DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY EDWARD LIVEING, B.A.

SCIENTIFIC ADVISER: A. S. RUSSELL, D.Sc.

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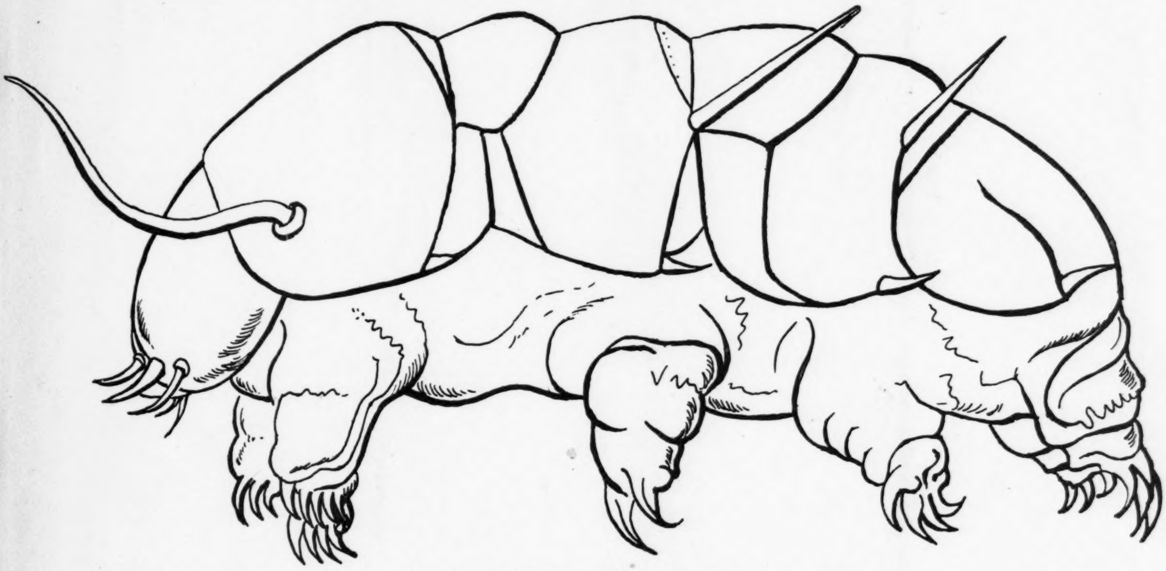

THE BEAR ANIMALCULE
Highly magnified

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JOHN MURRAY, 50A ALBEMARLE STREET, LONDON, W.1.

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DISCOVERY. A Monthly Popular Journal of Knowledge.

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Editorial Notes

"AFTER many summers dies the swan," sighed Tithonus, weary of immortality. The heroes of old myths, from the Wandering Jew down—shall we say?—to Ayesha, She-who-must-be-obeyed, found relief from humanity's last duty, that of dying, a gift of the Danaids, a fatal gift. Doubtless the myth of the lover of the dawn, growing eternally old, expresses that divine human power of acquiescence in the inevitable and of appreciating its excellences which makes cruel men whisper "Sour grapes." Man alone, say philosophers, has foreknowledge of death, though the big-game hunter believes in an intuition of mortality which makes the elephants foregather in lonely places when their hour has struck. But in fact it would seem that, though we all admit ourselves mortal, we are really gloriously incredulous about it. Nothing overwhelms our hearts with such devastating gloom as a scientist's prophecy that this world of ours has only another million years to last. Motor accidents we may laugh at; the ills which the flesh is heir to we may forget; but to hear that, inevitably, in one million years we will be frozen stiff or burnt out, as our authority of the moment teaches, is appalling news. No man can love his infinitely unborn grandchildren so much as to let their fate sadden him. We do not shudder at the tragic chillness of our forebears when the Ice Age came upon them. It is ourselves we would weep for, when we read, as in H. G. Wells's wonderful book *The Time Machine*, of a picture of the last living creature, all but lifeless in the frozen tropics.

* * * * *

This distaste of wholesale extinction, remote or imminent, has often received national and even worldwide expression. In the year 1000, it is said, pilgrims travelled like a devastating army to Jerusalem, there to await the inevitable end of the world. "A thunderstorm sent them all upon their knees in mid-march." Many times the return of comets has been the occasion for prophecies of universal extinction. In the year 1524, on the 1st of February, according to the astrologers, the Thames was to rise and wash away ten thousand London houses. The prior of St. Bartholomew's built a species of Noah's Ark to save himself and his household. Yet "Sweete Themmes ranne softly" that fatal day, as any other. Our astrologers—forgetful of the signs of the Zodiac, yet true to their traditional task of foretelling destruction—concentrate to-day on the eventual extinction of our sun. It is a commonplace that from it we draw all our means of existence, to it we owe our life. If we exclude some dislocation of celestial traffic, and a collision of our planet in mid-space, when we should all become extinct in the momentary glory of a new star, it is to the sun that we must turn our anxious eyes, when we are struck with the fear of a threat to our immortality. Of course, now and again other difficulties, due in a sense to our insufficient use of the sun, confront us. Professor A. H. Gibson, in his little book *Natural Sources of Energy*, has discussed some of them. The world's coal supplies, for example, may not last more than 350 years. The whole world's oil supply will last us 500 years; and the only other important source of stored-up energy, radium, will scarcely help us on our Tithonus-search of immortality. When we are approaching our five-hundredth year, doubtless we will turn our minds to the use of wind power, water power, tidal power, and direct sun energy to work our world. If, in point of fact, we ever do solve the problem of greatly prolonging the average life of man,

the Malthus problem of reproduction and food-supply production will become acute; although, as Dean Inge points out, it is the supply of food-stuff and the wherewithal to live that really limits the population of the world.

* * * * *

While our sun lasts, the using up of the earth's energy stores, while producing tremendous changes in the distribution of the world's population, will not gravely threaten man's existence, even in great numbers. While the winds blow and the waterfalls last there will always be great possibilities of energy production. And when the cooling sun tempers the vigour of the storms, and by the diminution of evaporation dries the water-courses, the tides can still be harnessed, and used, as they once were near Newhaven, in Sussex, for mechanical power. When we are well on in our hundred thousands, though still in the prime of our immortality, the seas will all freeze over—and where shall we then go for our sources of energy? There will be no further store inexhausted; forests and coal-fields, oil-wells and peat supplies will be long-forgotten luxuries. Perhaps we shall have learnt by then how to use the energy of the atom—how to chain the force of gravitation. Perhaps we shall be independent of the sun. At least we may hope so; is not necessity the mother of invention?

* * * * *

Meanwhile, what keeps our sun hot? Perhaps most people think of the sun, in a dim kind of way, as a gigantic bonfire, which will in time turn into a vast celestial ash heap. That is, however, certainly not true, because the highest known temperature of combustion is about 3,000 degrees, and the sun has a temperature of 6,000 degrees; and, moreover, it has been calculated that no bonfire could give more than 2,500 years of heat. The number of years during which the sun has been radiating heat energy is a difficult problem to solve; but estimates are usually expressed in hundreds of millions. Alex. Véronnet, astronomer at the University of Strasburg, who discusses the problem in the *Revue Générale des Sciences* (March 30, 1923), considers most estimates, which are based on such facts as the formation of rocks and the increasing saltness of the sea, to be too large. They assume that things took as long to happen millions of years ago as they do now; whereas, with a hotter sun the solution of substances in rivers, which causes the saltness of the sea, must have been a more rapid and complete process. Still, our earth and our sun have a long and distinguished history, and an explanation of the sun's heat must satisfactorily take into account these tremendous ages. Other theories have been suggested. Robert Mayer considered that the sun was fed by showers of meteorites. But this would involve an increase in the mass of the sun, and therefore an acceleration of the earth in its orbit and a shortened year. Even if meteorites within the orbit of the earth were to feed the sun, the alteration in the orbit of Mercury would be perceptible. There are many reasons, also, which render a theory of radio-activity as a source of sun energy inadmissible.

* * * * *

The theory which Lord Kelvin adopted and which Alex. Véronnet selects as most plausible was originally advanced by Helmholtz. His opinion was that the sun's heat was the result of the energy of its gradual contraction. Those who wish to investigate the basis of this theory cannot do better than refer to Monsieur Véronnet's article. The deduction from this theory is that in 100,000 years the mean temperature of this earth will be five degrees lower. In a million years, the temperature will be below zero, and the whole earth will be frozen over. Imagination dare not picture what the life of man, in that eternal arctic winter, will be. The change will have come so gradually that men will be reconciled to it. But it is a dismal picture. As one sits by a coal fire in winter, or lazes in the summer sun in these halcyon days of the sun's gracious middle age, perhaps we ought to be grateful that we have been born in what is probably the most bountiful and luxurious age the earth has known or ever will know. And we may think again before we regret that we may not hope to see the end of the story.

* * * * *

There is, however, another theory of the sun's heat which Monsieur Véronnet does not accept, but which English authorities prefer. They do not believe that the contraction theory accounts for more than a five-hundredth part of the energy of the sun. The alternative theory is based on the supposition that elements are formed from hydrogen. If that is so, the mass of their atoms ought all to be exact multiples of the mass of the hydrogen atom. In point of fact, their masses are in general a little less than the calculated figure. The discovery of isotopes by Aston, accounts, in a sense, for this discrepancy; but it is also possible, using the arguments which Einstein first brought forward, to explain the sun's energy by assuming that the extra mass has been turned into radiant energy. And such a theory postulates a far older sun, and a much greater lease of life on its present scale, than the contraction theory of Helmholtz.

* * * * *

We have received the following bulletin among the admirable series which Harvard College Observatory circulates:

HARVARD COLLEGE OBSERVATORY

BULLETIN 785

"*Results from Australian Eclipse.*—A night letter received at the Harvard College Observatory April 12 from Professor W. W. Campbell, Director of the Lick Observatory, states that three pairs of the Australia-Tahiti eclipse plates, measured by Campbell and Trumpler, with sixty-two to eighty-four stars on each plate, and with five of the six measurements completely calculated, give values between 1″.59 and 1″.86 for the Einstein deflection. The mean observed value of the deflection is 1″.74.

"The value predicted by Einstein, for the deflection of stars at the limb of the Sun, is 1″.74.

"HARLOW SHAPLEY."

CAMBRIDGE, MASSACHUSETTS.
April 13, 1923.

Every congratulation is due to the skilled observers who have obtained such a satisfactory result. The British expedition met with ill-fortune on their attempt to verify Einstein's predictions, since cloudy weather, as is described in *Science Progress* for April 1923, interfered with their plans. It appears, however, that we may have to modify our attitude towards these terribly involved questions of the nature of light and gravitation. At present it is too early to form a definite opinion, but it is at least possible that the fact that Einstein was proved so completely right shows him to have been in some respects wrong! In the main, his theories hold the field, but the work of Professor Eddington, of Cambridge University, has led to some radical alterations in his original attitude.

* * * * *

It is a familiar fact, and not altogether a surprising one, that it is possible to grow several generations of bacteria and other minute primitive forms of life on artificial foods—meat extracts, sugar, and jellies. The actual essentials of diet for these creatures are, however, very few in number, and in many cases life has been sustained without the aid of any food-stuffs so complicated as those we have mentioned—by the use of a few selected inorganic salts, and simple nitrogen compounds. It is less generally known, however, that for some years the actual cells which form the bodies of animals have been grown, in a very similar manner, for many generations, separated from the body in which they once grew. To those who are not familiar with the mysteries of the growth of the structural elements of our bodies, perhaps the most striking element in these tissue-cultures is the fact that some tiny fragments of the body can in this way continue living, almost indefinitely as far as can be seen, while the whole, of which they once formed a part, has long been dead. We know that primitive creatures, whose reproduction takes the form of a simple division into two parts, seem to have the gift of immortality—each is as old as its neighbour; each is new-born with the birth of its progeny. The reproductive cells of higher animals, the "gonads," which on uniting develop into the mature form, show this same property of immortality. But, since by careful attention it has proved possible to grow glands, nerves, and heart fragments for indefinite periods, it would seem that this immortality is the property of all living matter, and we return to the theories of those who have believed that death was an accident, and immortality within our grasp. It must be admitted that up to the present we can only persist as minute isolated fragments—a privilege little happier than that which the inhabitants of Central Asia believe their relations, who have been eaten by vultures, and thus become living matter again, to enjoy.

* * * * *

Dr. A. H. Drew, D.Sc., of the Imperial Cancer Research Fund, has described the technique of this exciting research, and some of its more suggestive results, in the *Lancet* of April 28, 1923. Those who have had an opportunity of seeing, through a microscope, a minute part of a heart, beating vigorously without any blood to circulate, or a number of cells from the cartilage of a joint, dividing up before our eyes, "foaming" and putting out little tentacles, will be convinced that the study of these marvellous happenings cannot fail to be of immense importance to many branches of medicine. For years fierce battles were fought over the question of the origin of the heart-beat—was it controlled by nerves, or did it beat of its own accord? Tissue-culture proves that the heart certainly beats of its own accord, however much nerve control may vary its beat. Again, "fatty degeneration" of the cells of the body is a morbid condition familiar to pathologists, but very obscure in its nature. It has been imitated in tissue-culture. Perhaps, however, the most important results have been obtained in connection with the study of cancer cells. It has been found that they contain, ready made, growth-stimulating substances which other cells only provide when they are broken up. A tissue-culture whose growth is slow may be speeded up by the addition either of broken-up ordinary cells, or by living cancer cells. This fact seems to us among the most significant discoveries which have been made up to the present in this connection. We have frequently drawn attention in these notes to the great importance to humanity of any new fact which can be produced in relation to the terrible plague of cancer. Tissue-culture, we are convinced, offers unique opportunities for the investigation of the problem, and we look forward with great interest to the further researches of Dr. Drew, and of other

workers, who are pursuing similar studies at the Research Hospital in Cambridge.

* * * * *

Professor A. Mawer's article on "Place-names" in a recent number of this journal proved of great interest to many of our readers. One of the advantages of living in an island rich in history—of invasions, peaceful or the reverse, and of slow but peculiarly characteristic development—is that in the names of our country villages, and even in ourselves, we carry the material for the most thrilling researches. We are, as other nations rudely tell us, a mongrel race. What nation that has ever achieved greatness was otherwise? Our churches, Saxon, Norman, and Gothic, down to the nondescript tabernacles of to-day, tell their story to any week-end walker in the countryside. Names, however, are a more subtle problem; yet, as Professor Mawer pointed out, the story they tell is none the less clear and illuminating to the initiate. The English Place-name Society, with which not only Professor Mawer, but also Mr. O. G. S. Crawford, a frequent contributor to DISCOVERY, are intimately associated, has been formed to make a comprehensive survey of the rich mine of material which our land provides. The counties of Berkshire, Buckinghamshire, Essex, and Lincolnshire will be among the first to be surveyed, and the results are to be presented in forthcoming publications of the society. We feel sure that many of our readers will be glad to get into touch with this most interesting study, and full details will be given on application to the Hon. Secretary, The University, Liverpool.

Six Great Scientists. By MARGARET AVERY. (Methuen & Co., Ltd., 2*s.* 6*d.*)

We hear so little of the private lives of great scientists that we are inclined, sometimes, to think that they have none, that they live in a plane very different from our own, wherein test-tubes and mighty discoveries take the place of our little romances and everyday adventures. But in this book we read of many very human incidents which seem to bring us in much closer relationship to men who have revolutionised the thought and the practice of recent years. Pasteur, Lister, Darwin, Wallace, Mendel, and Galton are portrayed for us: we hear of Darwin's perpetual ill-health and brave endeavour in despite of it; of Lister and his unfortunate lapse at school, which forced his parents to withhold a "plumb cake"; of Pasteur's fervent patriotism and great kindliness. The main features of the life-work of these six eminent men are brought out in a most clear and interesting manner. The sex of the author is clearly shown in her very just emphasis on the influence of a well-selected wife on a scientist's work! We recommend this book as an example of interesting and stimulating biography.

Suspended Animation—I

By Sir Arthur E. Shipley, G.B.E., F.R.S.

Master of Christ's College, Cambridge

Tardigrades, Rotifers, and Nematodes

IN an article I wrote some year or two ago, dealing with Life, it was pointed out that Life was difficult, if not impossible, to define, but that living organisms have certain definite attributes such as breathing, feeding, moving, reproducing, and so on. There are, however, times when these functions are suspended.

If we collect some of the debris in gutters, amongst moss, or in holes in trees, or in ditches, and examine it under a microscope, we may be lucky enough to come across one or two specimens of a group of very small animals known as TARDIGRADA. These little creatures are minute, and in some cases transparent. Zoologically they are remotely connected with the great group of spiders, but they have no near relatives. They are provided with four pairs of legs ending in claws, and their slow and deliberate movements have earned them the name of Bear-animalcules. They live obscure and hidden lives, "remote from the world," as Cecil Rhodes described the lives of the Dons at Oxford. Of animals that consist of many cells, they are amongst the smallest, averaging one-third of a millimetre to one millimetre in length. So obscure are they that they are usually overlooked, yet Max Schultze asserts that they are, without doubt, the most widely distributed of all animals that are segmented.

The TARDIGRADA possess many features of interest. Some species look like dear little sucking-pigs in plate armour. In their natural state—in a damp atmosphere—they live, and move, and have their being, like any other animals; but if their surroundings dry up, or if one be removed and placed upon a slide and allowed to dry, then will their movements gradually slacken until they entirely cease. The body begins slowly but steadily to shrink. The outline and form are lost. The skin becomes wrinkled and folded, and in a short time it assumes the appearance of a much-weathered grain of sand, and all vital activities are suspended, or at any rate reduced to an unascertainable minimum. In this dried-up condition tardigrades may remain for many years without undergoing any visible change. If, however, they be moistened with water, the steps the animal underwent when drying up are retraced. The "grain of sand" begins slowly to swell; the wrinkles disappear; gradually a plump little animal—for they are so plump that you feel inclined to pat them, only they are too small—swells up; the legs stretch out; and slowly

the animal assumes its normal shape. For a time it remains quiet, and then it begins slowly and feebly to move about, and after a period which varies from

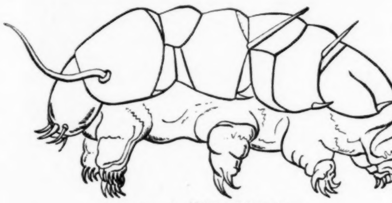


FIG. 1.—A TARDIGRADE.
Highly magnified.
(*From Doyère.*)

a quarter of an hour to several hours, according to the time its life has been suspended, the little animal crawls away " on its lawful occasions."

In the same sort of position, in gutters, amongst moss, are another group of animals known as the ROTIFERA or wheel-animalcules. These are creatures of singular beauty which bear on their heads a number of cilia whose rhythmic flickering produces an appearance of a wheel going round. More than 200 years ago Leeuwenhoek recorded the fact that these little microscopic animals were also capable of drying up, and resuming their normal activities when moisture is again applied. As long ago as 1774-5 Mr. Baker, in a letter addressed to the President of the Royal Society, stated that the animal described " can, however, continue many Months out of Water, and dry as Dust ; in which Condition its Shape is Globular, its Bigness exceeds not a Grain of Sand, and no Signs of Life appear. Notwithstanding, being put into Water, in the Space of Half an Hour a languid Motion begins, the Globule turns itself about, lengthens by slow Degrees, becomes in the Form of a *lively Maggot*, and most commonly in a few Minutes afterwards puts out its Wheels, and swims vigorously through the Water in Search of Food : or else, fixing by its Tail, works them

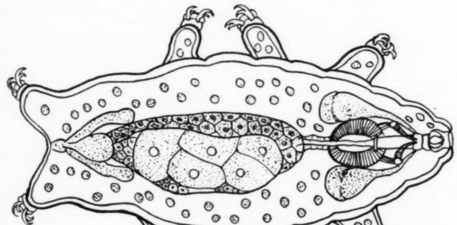


FIG. 2.—A TARDIGRADE, SHOWING INTERNAL ORGANS.

in such a Manner as to bring its Food to it. But sometimes it will remain a long While in the Maggot Form and not shew its Wheels at all."

Still another group of animals very widely distributed are the threadworms or NEMATODES. Some of these live freely in the earth or water, but a great number of them are parasitic or live inside the bodies of other animals or plants. Amongst the parasites of the latter is the threadworm which causes the ear-cockles in corn. These cockles are brown or purple galls or tumours which replace the grain of corn and each of which contains hundreds of minute microscopic thread-worms. Motionless and apparently dead, but not decayed, in these galls the little worm can live in dryness for at least twenty years. But when moistened, and this usually takes place by the gall falling on damp ground, they resume their activities, making their way to the young wheat plants and, wriggling up the leaves and stems, find their way again to the ear. Here they pair and lay numerous eggs from which the threadworms of the ear-cockle arise.

Snails and Slugs

It should be noted that, whereas in the case of the rotifers or the tardigrades the animal shrivels and loses its outline, this is not the case with the thread-

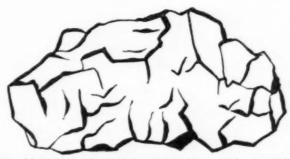


FIG. 3.—A TARDIGRADE, DRIED, IN A STATE OF APPARENT DEATH.

worm, and the suspended animation is prolonged and not seasonal. But many other animals in the temperate zones go into retreat during the winter, whilst in warmer climates they hide away during the hotter months of the year, or perhaps one had better say during the dry season. For instance, many snails hibernate during the winter. Most land-snails, as the first frost nips the vegetation, retreat under stones or into cracks or crannies in walls in tree trunks. Others bury themselves deep in the earth or under moss and leaves. Many common snails are often found living together in clusters, in some sheltered retreat, or, rather, not so much living as surviving. On the other hand, slugs usually hibernate alone. They excavate a nest in the earth, contract until they become almost spherical, and lie in their retreat in a hardened slime. The snails close their shells by the secretion of a membrane or chalky valve, and both snails and slugs take care to be in good condition before beginning their winter sleep. And for this reason our Allies who eat snails usually prefer those taken during the autumn. During this hibernation their breathing and circulation are reduced to a minimum and during the winter they lose weight.

Insects

Amongst insects, the adult forms occasionally hibernate, for instance the common house-fly. The great majority of house-flies die down in the autumn, but a few manage to live over the winter in retired crannies, especially in chinks in the timbers of warm stables, or hidden away in restaurants or kitchens. In the temperate regions of the northern hemisphere the butterfly known as the Painted Lady is the most ubiquitous of its kind. It passes the winter in the adult state. Dr. Sharp tells us: "In the temperate regions of the northern hemisphere *Vanessa* may be

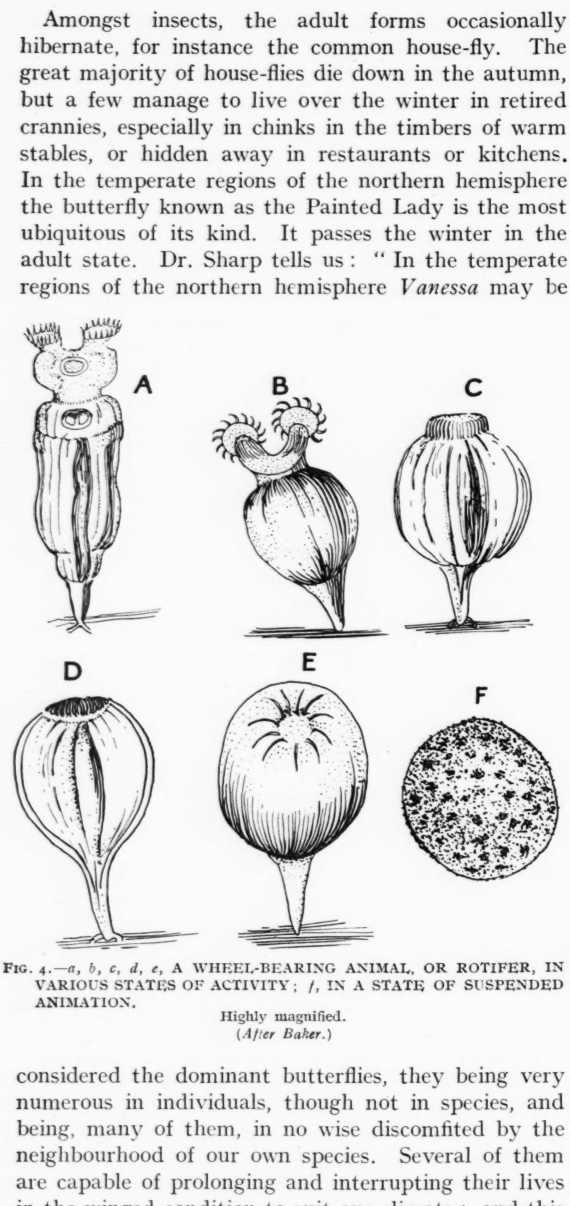


FIG. 4.—*a, b, c, d, e,* A WHEEL-BEARING ANIMAL, OR ROTIFER, IN VARIOUS STATES OF ACTIVITY; *f,* IN A STATE OF SUSPENDED ANIMATION.
Highly magnified.
(*After Baker.*)

considered the dominant butterflies, they being very numerous in individuals, though not in species, and being, many of them, in no wise discomfited by the neighbourhood of our own species. Several of them are capable of prolonging and interrupting their lives in the winged condition to suit our climate; and this in a manner that can scarcely be called hibernation, for they frequently take up the position of repose when the weather is still warm, and on the other hand recommence their activity in the spring at a very early period. This phenomenon may frequently be noticed in the tortoise-shell butterfly; it is as if the creature knew that, however warm it may be in the autumn, there will be no more growth of food for its young, and that in the spring vegetation is sure to be forthcoming. . . . It should, however, be recollected that many larvæ of butterflies hibernate as young larvæ after hatching, and, sometimes, without taking any food." As is well known, the activities of the inhabitants of the beehive, although lowered and to some extent in suspense, are still carried on. It is quite different with wasps and bumble-bees. The colony dies down and disappears; only the queen survives, and this she does in a motionless, inactive condition, hidden away in a crack in a tree or in a ditch. The majority of insects pass through the winter in a pupa or chrysalis stage, hidden away under leaves or buried in the ground. But as pupæ are generally inactive and motionless, the hibernation is not a very obvious alteration in their normal habits. Many beetles and several species of dragon-fly hibernate during the winter in a larval state, and as the former are very often found embedded in burrows in trees they do not require a special winter home. The larvæ of the dragon-flies and of the may-flies hide themselves in the side or muddy bottom of their native pools.

Towards the close of autumn the whole insect world in temperate climates is on the move. Like the executive of the Government at Washington during the time of the Presidential Election with the parties changing sides, they are all "making for cover." Lady-birds, field-bugs, and flies have retired into their winter-quarters well before the first frost has occurred; very often on the hottest autumn days.

To those who are on the outlook, the coming together of numerous species of beetle on quiet autumn days is as striking as the assemblage of swallows before they take their autumn flight for sunnier climes. Kirby recalls that whilst "walking on the banks of the Humber on the 14th of October about noon—the day bright, calm, and deliciously mild, Fahrenheit's thermometer 58° in the shade—my attention was first attracted by the pathways swarming with numerous species of rove-beetles (*Staphylinus, Oxytelus, Aleochara,* etc.), which kept incessantly alighting, and hurrying about in every direction. On further examination I found a similar assemblage, with the addition of multitudes of other beetles, *Halticæ, Nitidulæ, Rhynchophora, Cryptophagi,* etc., on every post and rail in my walk, as well as on a wall in the neighbourhood; and on removing the decaying mortar and bark, I found that some had already taken up their abode in holes, from the situation with their antennæ folded, evidently meant for winter-quarters." The aphis passes the winter both in the egg and in the perfect state. All these insects fall into a coma. At first they are but partially benumbed, and when touched are still capable of moving their limbs. Soon,

however, the insect practically ceases to breathe, to feed, or to move. The muscles lose their irritability and they have all the appearance of being dead. Whereas in the case of the ROTIFERA and TARDIGRADA the suspension of life is due to the drying up of their watery surroundings, the hibernation of insects and snails, and—as we shall see later—of various forms of vertebrate animal, is due mainly to the onset of winter. It is a seasonal occurrence, though in many cases we shall notice that in the tropics, where animals retreat during the hotter months (æstivation), the hotter months coincide in time with the drying up of the surroundings.

(*To be continued.*)

[Our thanks are due to the proprietors of the *New York Evening Post* for permission to reprint portions of this article.—ED.]

Industrial Stability

By A. C. Pigou, M.A.

Professor of Political Economy in Cambridge University

A LEADING note of the industrial activity of modern states is its fluctuating character. Not only do we find from time to time one industry expanding while another decays, but also besides the *relative* fluctuations, there are more or less rhythmical fluctuations of an *absolute* kind in industry as a whole. It is these absolute fluctuations that economists are accustomed to refer to under the name of the trade cycle. They do not, of course, occur in the form of equal proportionate movements in each several industry. On the contrary, they are always combined with *relative* fluctuations occurring at the same time. In booms the constructional industries expand relatively to other industries, and in depressions they contract relatively to them. But, over and above these relative movements, there is also an absolute movement on the part of these two sorts of industries taken together, which is associated with fluctuations in the aggregate volume of work done throughout the country as a whole.

Now it could not be laid down *a priori* that fluctuating activity as such must be less favourable to human welfare than regular activity of equal aggregate amount. There is no reason, for instance, to believe that the world would be a better place if, instead of being wholly awake in the day and wholly asleep at night, people were half asleep all the time. Is there any more reason to believe that it is worse for people to work for three or four years very hard and then for three or four years rather slackly than it would be for them to work moderately hard every year? The answer, it would seem, must depend on the physical and psychological constitution of human beings, and could not, therefore, be derived from economic considerations alone. In actual life, however, the question is not put in this highly etherealised form. We know that, as a matter of fact, with industry organised as it is, periods of depression are associated, not with relaxed work for everybody, but with total unemployment for a certain number of people, and we know that, whatever there may be to say in favour of alternations of hard work and holidays, there is nothing to say for alternations of overtime and involuntary unemployment. No doubt, it is possible, by various palliative measures, to diminish substantially the social evil that unemployment carries with it. But, in spite of this, nobody seriously denies that, as things actually are in the modern world, general industrial fluctuations involve grave injury to welfare, and that, if somehow greater stability could be introduced, there would be a very large social gain.

It is not difficult to show that, even if we had a monetary system so contrived as to keep the general level of prices approximately constant, some degree of cyclical industrial movements would still take place. There would be alternations of business confidence and business malaise; at one time all the various groups of people concerned in different sorts of production would over-estimate the rate at which their stuff, if they produced it, would exchange for other people's stuff; when the stuff, after a period of incubation, was finished and ready for trading, they would all discover their error: and, in consequence, pessimism and a period of contracted output would set in. Though, however, this is true, it is also true that the cyclical fluctuations of industry, which would thus take place even under a régime of stable general prices, are much aggravated when the monetary system is of such a sort that these prices rise in booms and fall in depressions. For the persons in control of industry are, in the main, debtors in terms of money, so that, when prices rise, the money payment they have to make in interest remaining the same, the real payment is diminished, and, when prices fall, the real payment is increased. This means that in periods of boom, when they are already somewhat over-confident, business men receive an additional fillip in the form of a bounty at the expense of their creditors; and in periods of depression, when they are already unduly pessimistic, they receive an additional discouragement in the form of a tax for the benefit of their creditors. Moreover, since business men generally foresee future movements rather better than the people from whom they borrow, they may look, when prices are rising, to obtain *new* loans on better terms than they could do if everybody's foresight was equal;

*

and, when prices are falling, to obtain them on worse terms. This adds still more to their cheerfulness in booms and to their despondency in depressions. The net result is that industry progresses in waves of an amplitude substantially greater than would appear if general prices were so chained that they could not rise in booms and could not fall in depressions.

The Gold Standard

From what has been said it follows that, other things being equal, industrial stability will be promoted the more effectively, the more fitted is our monetary system to ensure price stability both in periods of boom and in periods of depression. Before the outbreak of the Great War the money of the United Kingdom was based on the gold standard, and this fact prevented booms and depressions here from carrying general prices substantially above or below the contemporary level in the world generally. If they began to soar above this level, goods tended to flow into this country and gold to flow out, with the result that the upward movement was checked ; and, if they began to fall below this level, the downward movement was checked by a corresponding mechanism. In the face, therefore, of booms and depressions private to the United Kingdom, general prices were chained fairly tightly and could not move much. But, of course, in fact booms and depressions often extended much beyond the United Kingdom, and, when this happened, though domestic prices could not move far away from world prices, domestic prices and world prices might both move a long way from their original position.

In the difficult period of the Great War the gold standard was abandoned in effect in all the belligerent countries, and, though the money of the United States is now a full gold money, the moneys of the principal European countries are no longer convertible at their face value into gold, and the money of the United Kingdom, though nominally so convertible, is really placed on the same footing as the continental moneys by legal prohibitions against the export of gold and the melting of sovereigns. The abandonment of the gold standard implied a rupture of the chain by which upward and downward movements of general prices had hitherto been held in check. This made possible the enormous price swings that were associated with the post-war boom and the depression following it. If, indeed, the Bank of England had raised the discount rate earlier and higher than it did, the amplitude of these swings would have been lessened. There were special obstacles in the way of such action by the Bank at that time, and it may be argued that, in future booms, we might rely on general prices being chained down by discount policy not less effectively than they would be chained by the gold standard. Since, however, it is generally agreed that, in this country at all events, the gold standard must, on other grounds, be restored at the earliest possible moment, it is not necessary to argue that point. As a matter of history, the abandonment of the gold standard not only made possible, but was also in actual fact associated with, altogether abnormal swings in the general price level.

When we have got back to the gold standard, as, no doubt, we presently shall, there is some danger that the problem of price stabilisation, which has recently been much discussed, will be allowed to sleep. Happy in having escaped from our present ills and returned to pre-war currency conditions, we may be inclined to treat as academic and unpractical proposals designed to improve on these conditions. But, as I have shown above, the gold standard, though an effective chain upon price movements in booms and depressions private to a single country, is not effective in booms and depressions of world-wide scope. Plainly, therefore, pre-war currency arrangements were not perfect, and, if it should prove possible to improve on them, it is very desirable to do so. A number of plans to this end have been discussed among economists. Some of them involve international action, but others, at the cost of a number of rather serious disadvantages, could be adopted by a single nation. It would not be appropriate to examine the technique of these plans here. It is in place, however, to call attention to the fact that such plans exist. When England is once more back on the gold standard, our Government, in conjunction with that of the United States and of other interested countries, might very usefully set up an international Commission to investigate the whole subject.

Simple Remedies

It is not, however, only through price stabilisation that industrial stabilisation can be promoted. Governments—and under the term " governments " we must include municipal and other local authorities—have it in their power to contribute something towards that end in a simpler and more direct way. There is a large amount of work for the initiation of which, whether by themselves undertaking it or by ordering it from private contractors, they are themselves normally responsible. A good deal of this work is such that it does not very greatly matter whether it is done in one year or in another neighbouring year. By pressing on work of this kind in periods of depression and holding it back in periods of boom, government authorities can, if they choose, make industry and employment as a whole somewhat steadier than it would otherwise be. It is sometimes objected that

this kind of action could not really achieve the end sought by it, because, whatever extra money government authorities spend on government work during depressions, must, in one way or another, be withdrawn from the funds which private people would otherwise have spent on private work ; so that, though a difference would be made to the type of work done in depressions, no difference would be made to its aggregate quantity. This argument, however, fails to take account of the elasticity of our banking machinery. That elasticity makes it possible from time to time for the money expenditures of one portion of the community to be substantially increased without those of the other portions being correspondingly diminished. It also fails to take account of the fact that, if a depression is allowed to run its normal course, government authorities will have to expend large sums in the relief of unemployed workpeople, and that, therefore, those funds are available for setting industry in motion to the extent that expanded industry diminishes the volume of unemployment. There are, of course, important difficulties of detail in the way of using government demand as a kind of balance wheel to offset oscillations of private demand, and it would be a mistake to expect too much from it. *In principle*, however, the policy is a sound one and is not open to objections of a fundamental sort.

Improvement in the monetary mechanism with the direct object of promoting steadiness in general prices and adjustment of orders on the part of government authorities are the most obvious and most frequently discussed means of increasing the stability of industry There are, however, other means, some of them in the control of individual manufacturers or groups of private consumers, by which a small contribution to the same end might be made. Individual manufacturers have a certain freedom as to the policy they will adopt about making for stock, and private consumers have the power, just as government authorities have, to adjust, in the general interest, the period at which some of their less urgent orders shall be given. We cannot hope, in any event, however strenuously everybody may work for that end, that the trade cycle will be smoothed out altogether. But there is reason to believe that more can be accomplished in this direction than has been accomplished hitherto. The subject is one that has not yet been fully investigated. It is difficult on the technical side, covers a wide range, and is interwoven with a number of matters that seem at first sight to have no relation to it. But, on the other hand, it has a very direct bearing upon the real welfare of the community ; and students of it may reasonably hope that their work, if successful, will yield fruit as well as light.

Plant Life in the Antarctic

By R. N. Rudmose Brown, D.Sc.

THE prevalent belief that Antarctic regions are entirely devoid of vegetation is far from the truth. It arises partly from the meagre collections from the far south until recent years, and partly from the contrast with the comparatively rich vegetation of North Polar regions. It is true that the surface of the great Antarctic ice-cap which covers nearly the whole of the continent is devoid of plant or animal life, but around the edges of the continent where ice-free rocks appear, and on the islands which fringe it in places, vegetation is far from negligible.

The region which experiences true Antarctic conditions is bounded approximately by the parallel of lat. 60° S. To the north of this parallel lie the subantarctic regions comprising such island groups as South Georgia, probably the South Sandwich group, and certainly Kerguelen. Within the Antarctic region lies the whole of the Antarctic continent and such island groups as the South Shetlands and the South Orkneys. The Antarctic Circle is neither a geographical nor a climatic frontier, and it is entirely fallacious to regard it as the boundary of Antarctic regions.

The Antarctic flora, thus defined, has been examined in various places, and its general aspect is well known, even if subsequent exploration will undoubtedly add a few species of cryptogams. Its poverty compared with the flora of the same latitudes in North Polar regions is striking. While Arctic regions support some 400 species of flowering plants, many of which flourish luxuriantly, Antarctic regions support but two, neither of which does more than maintain a precarious hold. These species are a grass *Deschampsia antarctica*, and a small caryophyllaceous plant[1] *Colobanthus crassifolius*. The grass was first discovered in the South Shetlands, south of Cape Horn and Drake Strait, over a century ago by J. Eights, the surgeon of a sealing vessel. In recent years it was rediscovered on the west of Graham Land and on adjacent islands by both Belgian and French Antarctic expeditions, between lat. 65° S. and 68° S. It is known also from Fuegia, the Falklands, South Georgia, and Kerguelen. The other plant is a comparatively recent discovery, the French Antarctic expedition having found it in several places along with the grass. It, too, must be regarded as a straggler from Fuegia, where it is more at home ; it grows also in the Falklands and South Georgia.

[1] This is the order to which the familiar British plant, the white campion, belongs.

In spite of careful search in other parts of Antarctic regions, these plants have not been found elsewhere, although there is a possibility of their occurrence in the South Orkneys. They grow sparingly in scattered groups and give the impression of being almost at the limit of possible existence. Reproduction would appear to be entirely vegetative.

Ferns are entirely lacking in the Antarctic, but mosses are numerous and, in fact, are one of the chief constituents of the flora, in individuals if not in species. Well over fifty species are now described from Antarctic regions, of which the majority come from the Graham Land region and neighbouring islands. Many specimens show a vigorous, even luxuriant, growth, and this is specially notable in certain species that have a wide distribution throughout high latitudes. The specimens from Victoria Land in lat. 78° S. are stunted and miserable compared with those from Graham Land fifteen degrees farther north. In the far south they are frozen solid, as hard as rock, for some ten or eleven months, in Graham Land and the South Orkneys for seven or eight months, but this experience does not seem to impair their vitality. The mosses generally grow in small colonies, in favoured places, in which a number of species are to be found. In some cases a small tundra of moss and lichen vegetation half an acre in extent may be found. Such places are favourite nesting-places of skuas and gulls ; the bird guano provides a valuable fertiliser to the moss. Most Antarctic mosses reproduce vegetatively[1]: fruiting specimens are rare. Dr. J. Cardot, the great authority on Antarctic mosses, says that among all the specimens he has examined only six species showed fruits. Even among the specimens from the South Orkneys, where moss growth is luxuriant, only one species showed many well-developed fruits

Antarctic hepatics or liverworts are rare. The half-dozen or so of species seem all to have been recorded from the Graham Land region. They are generally found growing in the shelter of moss colonies. Lichens are numerous, and both as species and individuals form the predominant feature of Antarctic plant life, marine algæ excepted. Even in mid-winter a few precipitous rock faces may show a touch of colour due to lichen growth, while in summer there are great patches of brilliant orange, due mainly to various species of *Placodium*, and shaggy growth of a luxuriant species of *Usnea*. There are few, if any, areas of bare rock in summer which do not support some lichen growth. Dr. O. V. Darbishire has recorded over 100 species of lichens in Antarctic regions. Subsequent exploration will certainly add to this number.

[1] Vegetative reproduction is shown by plants which, like the begonia, can multiply without the production of seeds.

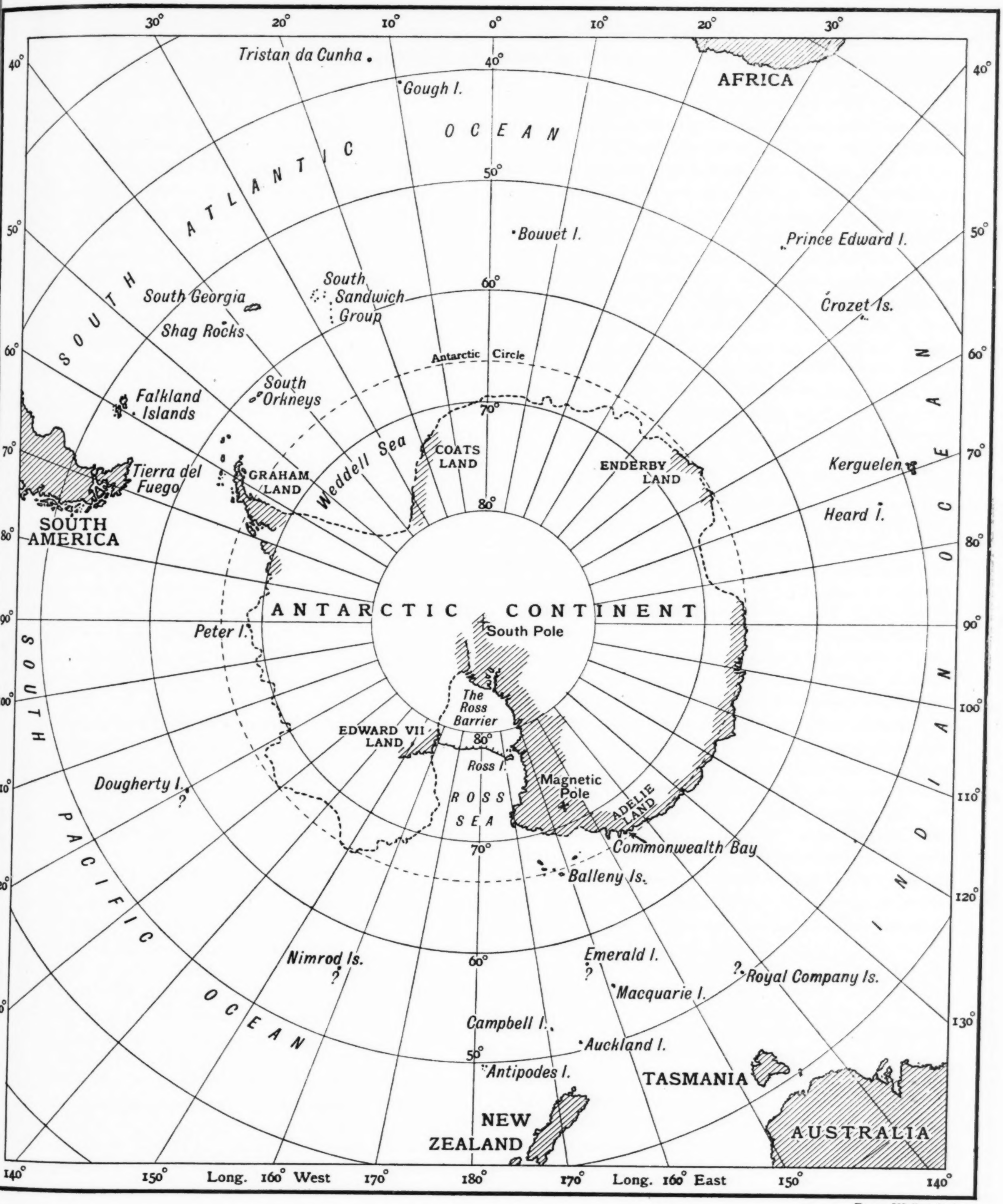
Red Snow

Fresh-water algæ are comparatively abundant. In the South Orkneys alone sixty-eight species were recorded. The forms of most interest are those that give origin to red and yellow snow. Red snow is not very common, but has been recorded from various parts of Antarctic and Arctic regions, as well as from extra-polar regions. Dr. Fritsch, on examining South Orkney material collected from a patch of red snow, found it to be due to an algal association ; but in Victoria Land Mr. J. Murray attributed the colour not to algal growth, but to the presence of red rotifers. These have been found in red snow in the Alps, but, as far as I am aware, not in Arctic regions. Yellow snow is rare. At the South Orkneys it is due to a remarkable association of eighteen species of algæ and two of fungi, with a character so reminiscent of plankton[2] that it may be due to wind carriage of plankton forms on to the land. This must not be confused with the yellow coloration of sea-ice which is due to included diatoms. In yellow snow diatoms are rare.

Marine algæ are very abundant in Antarctic seas. As in Arctic waters, the rock pools and shore-line generally are comparatively free from seaweeds owing to the scouring action of the ice. This gives a false impression of the poverty of marine life. In water over 10 or 15 feet in depth there are many seaweeds; in shallow water only calcareous algæ encrusted on the rocks are at all conspicuous.

Unicellular marine algæ occur in enormous numbers. Sir J. Hooker was the first to demonstrate this phenomenon, and since his day every expedition has corroborated his statement, though comparatively few have made exhaustive collections. South of lat. 60° S. the plankton changes its character: animal forms become scarce and plant forms predominate. In the regions of pack-ice diatoms and a few peridinians constitute the surface life of the sea. A few minutes' haul of a fine silk net results in half a pint to a pint of gelatinous matter which is almost wholly composed of diatoms. Some ten or twelve species are very common, and some forty to fifty are rarer. The Arctic seas show the same abundance of diatoms, sometimes to such an extent that the sea appears bright green for several acres. This discoloration of the sea has seldom been recorded in the Antarctic. It is of interest to note that Dr. L. Mangin finds on comparison that the Arctic and Antarctic diatom floras are practically distinct as regards species, and that there is also much difference in various parts of Antarctic seas.

[2] "Plankton" is a general name given to those minute forms of sea life which exist either on or just below the surface of the ocean.



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Antarctic and Arctic Contrasts

The contrasts between Antarctic and Arctic land floras are very notable and demand explanation.[1] The extent of insolation is of course the same in corresponding latitudes in northern and southern hemispheres. The annual snowfall in the south is probably not greater than in the north, and the winter temperatures, at least in certain parts of Antarctic regions, are not more severe than in parts of Arctic regions. The real explanation is to be found in the short summer with its remarkably low temperatures. Thus in Victoria Land in about lat. 78° S. the mean of the warmest month of the year is only 25° F.; at Cape Adare in lat. 71° 18′ S. it is 31·5° F.; at Snow Hill, Graham Land, in lat. 64° 24′ S. it is 30·4° F.; and at the South Orkneys in about 61° S. it is 32·9° F. Thus there is practically no month in the Antarctic with a mean temperature above freezing-point, while the mean of the three summer months, December, January, and February, is everywhere below 32° F. In Arctic regions summer is warmer and longer. The mean summer temperature (June, July, and August) in Spitsbergen is over 37° F., and the mean of the warmest month, July, is over 40° F. In Franz Josef Land in lat. 80° N. the July mean is 35° F. In other words, the Arctic summer has a mean well above freezing-point.

This lack of a real summer influences Antarctic plant life in two ways. The winter snow lies late on the ground, and December is generally well advanced before most of the vegetation is laid bare and exposed to sunlight. By early February snow again begins to accumulate, and it may cover the ground throughout the so-called summer. There are only some four to six weeks during which the vegetation, except lichens on cliff faces, is likely to be exposed to the sunlight, and the probability is that the ground has a temperature not above freezing-point even if it is not saturated with ice-cold water: often it thaws only for a few hours on cloudless days when the sun is strong. These influences are detrimental enough to plant life, but the impossibility of completing the cycle of life-functions in the short cold summer causes the virtual absence of flowering plants. A plant would be unlikely to reach the flowering stage and would have no chance of maturing its fruit. Even Arctic plants in their more favoured circumstances rarely ripen their seeds and frequently reproduce vegetatively. With an average of eight to ten weeks, when the ground at low elevation is free from snow, Arctic plants have to "rush" their life-cycle, flowering frequently before the snow is off the ground, and even then finding the summer too short. Antarctic conditions, with low temperatures and the uncertainty of even four weeks clear of snow, deny even this possibility.

Winter temperatures fall very low, but there is no reason to suppose that a mean of – 30° F. is any more prejudicial to plant life than a mean of zero. Throughout the Antarctic winter all temperatures are uniformly low enough to give all mosses the hardness of rock.

These probably are the main reasons of the poverty of the Antarctic flora, but there are contributory factors. The chief sites for plant growth are the islands, particularly small ones, and the rocky coasts. In such places high winds help to keep the surface clear of snow, but these high winds, not infrequently dry and generally cold, are themselves detrimental to plant growth. Nothing could be more hostile than the strong southerly and south-easterly winds blowing from the high-pressure system over Antarctica. The lack of soil has been suggested as an adverse influence. This is doubtful if one considers the habitat of many Arctic plants which, for example, in Spitsbergen maintain a hold on raised beaches, moraines, and even on rock faces. In places the level plain of the Antarctic provides 6 to 8 inches of soil, often well impregnated with bird guano, which might furnish suitable sites for the flowering plants. The Antarctic, however, has one influence hostile to plant life that is absent in the Arctic. In summer myriads of penguins haunt the islands and coasts of Antarctica, occupying all the low-lying sites that are first to lose their snow, that is to say, exactly the best sites for plant growth. In the proportion of one per square yard the penguins cover every available site; nothing escapes their insatiable curiosity or fails to be attractive to their beaks. No plant that had gained a footing would stand the smallest chance of surviving. It is not unreasonable to regard the penguin as one of the agencies hostile to plant growth in the Antarctic.

The Origin of Antarctic Flora

The origin of the Antarctic flora presents a fascinating problem. How did these species of plants reach Antarctica? It would occupy too much space to analyse in detail the distribution of every Antarctic species, but it may be noted that certain elements are conspicuous. There are the endemic element, which is high in the case of mosses and lichens; the Arctic element; and the Fuegian element. The high proportion of endemic species can well be explained by long isolation and peculiar conditions of environment. The Arctic element is not easy to explain. Two suggestions have been made. Carriage of spores and soredia in the feet and plumage of birds which wander through 150° of latitude may account for some species. Wilson's petrel and the Arctic tern are birds with this

[1] See article on "Greenland's Plant Life," by Prof. A. C. Seward, DISCOVERY, September 1922.

wide range. At the same time it is difficult to find in this means an adequate explanation of the fact that practically half the Antarctic lichens and 30 per cent. of the mosses are found also in the Arctic. A simpler and more credible explanation may be found in the idea that the species in question are either cosmopolitan and have not been discovered in low latitudes, or that they are species which have been crowded out by stress of competition in low latitudes where conditions more favourable to plant growth mean more contest for location.

There seems to be much evidence that the present Antarctic flora, like the sub-antarctic flora, is mainly of Fuegian origin, and has migrated eastward before the prevailing westerly winds, both bird and wind transport having played their parts. Ice transport plays no part outside the pages of a few textbooks. This evidence I have analysed elsewhere, and there is no reason, in the light of later knowledge, to modify the conclusions. It might, however, be noted that former land connections which there is every reason to believe connected Antarctica at least with South America, if not New Zealand and Australia, cannot be held responsible for any of the present Antarctic flora. Apart from the fact that these land connections probably were lost in Tertiary times, there is ample evidence that a great extension of glaciation occurred at a later date. This must effectively have destroyed every vestige of vegetation in Antarctic regions. The present flora must have migrated to the Antarctic in recent geological times, since the period of maximum glaciation.

The literature of Antarctic botany is considerable. For a discussion of the origin of the flora reference may be made to "Problems of Antarctic Plant Life," R. N. Rudmose Brown, in *Report on Scien. Results S.Y. Scotia*, vol. iii, 1912, and papers in same volume by J. Cardot on Mosses, F. E. Fritsch on Fresh-water Algæ, and O. V. Darbishire on Lichens. Contributions of importance occur in *Wissen. Erg. der Schwedischen Südpolar Exp.*, vol. iv, including J. Cardot on Moss flora, O. V. Darbishire on Lichens, and C. Skottsberg on Algæ; and in *British Antarctic Exp.*, 1907–9, *Report on Scien. Invest.*, W. and G. West on Fresh-water Algæ.

The Bacteria of the Soil

And the Utilisation of Organic Antiseptics

By P. H. H. Gray, M.A.

Rothamsted Experimental Station

THE great importance to plant-life of the presence of bacteria in the soil was first recognised in connection with their powers of dealing with that vital element, nitrogen. It is now well established that there are bacteria present which have the amazing property of "fixing" the nitrogen of the air, and handing it over to plants in a form of which they can make use; and not one process, but a whole chain of processes, is involved in their many-sided activities. It is not easy to see how life could ever have been developed to its present scale apart from them.

A less friendly bacterium from the agriculturist's point of view is that which competes with crops for the nitrates present in the soil. The decomposition of the cellulose which forms the framework of plants has engaged the attention of McBeth and Scales in America and of Hutchinson and Clayton at Rothamsted, and important knowledge has been acquired as to the action of carbohydrate substances such as sugar and straw, which are present as the residues of former crops, and which serve the bacteria as a source of energy sufficient to enable them to use the nitrates for their own purposes and to deprive the crops of them.

Carbohydrates, however, are not the only nitrogen-free organic compounds that occur in the soil. Other compounds, though present in smaller quantities, may be of considerable importance. Phenol, which we know better under the name of carbolic acid, and related compounds are found in the soil, being formed by bacterial action in the intestines of animals and probably even in the soil itself. The amount of phenol produced, though small, is by no means negligible; thus Mooser calculated that with a dressing of liquid manure anything from 30–74 lb. of phenol may be added to the acre. Such compounds, if they persisted in the soil, would accumulate, and ultimately prove a source of plant poisoning. Dr. Brenchley at Rothamsted has, indeed, shown that in water-culture experiments the addition of small doses of phenol is poisonous to plant growth. The disappearance of phenolic compounds even from heavily manured soil indicates that a mechanism must exist by which they are removed or destroyed.

The Disappearance of Antiseptics

The problem of the destruction of phenol compounds in soil became of practical importance owing to the use of such substances in the tomato-growing industry as soil-sterilising agents. In glass-houses, cresylic acid, which is a substance of this kind, is applied to the soil for the purpose of killing such destructive tomato pests as the eel-worm, Heterodera. It is found, however, that unless added in strong concentrations, phenol and cresol disappear from the soil with considerable rapidity, so that their full effect on the pests is not felt. A parallel case is that of naphthalene, which

forms the basis of some soil insecticides. The full utility of this compound, also, is impaired by the fact

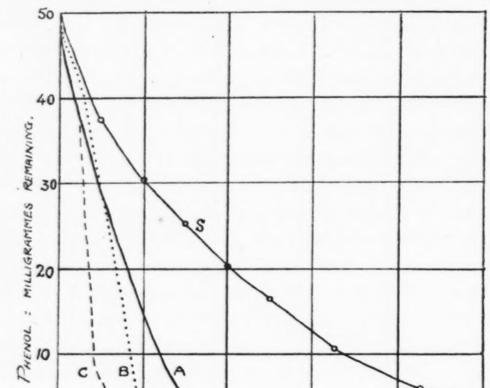

FIG. 1.—DISAPPEARANCE OF PHENOL FROM MANURED SOIL.
S = Disappearance from sterilised soil.
A, B, C = Disappearance of three successive doses from a single soil sample. (After Sen Gupta.)

that it disappears too rapidly when added to the soil. The cause of the disappearance of these antiseptics from the soil was therefore studied at Rothamsted with the object of preventing their rapid loss, and so prolonging their antiseptic action.

A study of the disappearance of phenol, from the chemical point of view, was made by Sen Gupta, who found evidence that two causative factors were involved, a purely chemical or physical cause, and a biological cause. If a dose of phenol be added to soil in which all the bacteria have been killed by treatment with mercuric chloride, the disappearance is at first rapid, but soon takes place at a slower rate. Evidence has been adduced that this disappearance is due to the reaction of the phenol with a chemical substance in the soil. In normal unsterilised soil, on the other hand, the disappearance of the same dose of phenol is much more rapid and follows a less regular course. A second factor causing the disappearance has therefore been removed by the sterilisation. The probability that this factor is biological is shown by the fact that if three successive doses of phenol be added to the same sample of soil, the second dose disappears more rapidly than the first, and the third more rapidly than the second. This is what would be expected if the disappearance were due to organisms multiplying in the soil following the addition of the phenol, but it is very hard to explain on the supposition that the disappearance is purely chemical or physical. The curves in Fig. 1 show graphically this accelerated loss.

The Function of the Bacterium

Evidence of this type has led the Bacteriology Department at Rothamsted to search for phenol- and cresol-destroying bacteria in the soil. The existence in nature of certain bacteria capable of attacking phenol was already known. On sewage filters the phenol, which is known to be formed by bacteria, does not accumulate, and this fact led Fowler, Ardern, and Lockett in 1910 to study the subject of its disappearance. They were successful in isolating an organism capable, in pure culture, of feeding upon phenol. Later, Wagner in Germany isolated from various sources bacteria which could utilise benzene ring compounds, a class to which naphthalene belongs, as supplies of energy.

An examination of the soils around Rothamsted showed that they contained soil bacteria capable of attacking phenol, cresol, toluene, and naphthalene in pure culture. The organisms that have been isolated can use some or all of these compounds as the source of energy for carrying out their life-processes, and are able to grow rapidly in a solution containing the antiseptic and no other food supply than inorganic salts. Since the phenols are strongly antiseptic in their action on most bacteria, it is especially remarkable that organisms commonly occur in the soil that can feed on these compounds. The decomposition of naphthalene by soil bacteria is even more remarkable, since it is inconceivable that the bacteria can meet with it to any significant extent in a state of nature.

FIG. 2.—BACTERIA WHICH DECOMPOSE ANTISEPTICS GROUP D. × 1,000.

Having found that bacteria capable of attacking organic antiseptics occurred in Rothamsted soil, it was necessary to decide, firstly, whether similar

organisms were common in other soils, and, secondly, which of the various bacteria isolated were of chief importance in causing these antiseptics to decompose in the soil itself. To settle this first question, about 150 soil samples were collected, with precautions to exclude outside contamination, from a wide area in Great Britain, and the phenol, cresol, and naphthalene bacteria were isolated from them. It was found that, although some 200 strains of antiseptic-decomposing bacteria were obtained from over this wide area, they fell into four main groups, three of which had already been found in Rothamsted soil.

These groups were :

A. A number of Pseudomonads similar to the common organism Ps. fluorescens-liquefaciens.

B. A few varieties of small rod-like bacteria.

C. A number of large rod-like forms that produced spores.

D. A group perhaps related to the tubercle bacillus.

These latter organisms undergo remarkable changes in appearance under cultural conditions. (See Fig. 2.)

Geographical Range of Bacteria

The first three groups appear to be widely distributed over Great Britain, but the last group has an interesting and so far unaccountable geographical range, since it is apparently not evenly distributed over the area searched, being abundant in the south-east and middle of England and in the Edinburgh and Glasgow area, but very rare in the North of England and in the rest of Scotland.

Phenol and naphthalene organisms are also known to occur in soils from other countries, having been found in soils from Norway, the Tyrol, and Gough Island in the South Atlantic. As it appears, therefore, that they are of world-wide occurrence, there is reason to suppose that the results of the study of phenol, cresol, and naphthalene decomposition at Rothamsted will be applicable to other parts of the world.

The second question—namely, as to which group of organisms is chiefly effective in decomposing these antiseptics in the soil itself—cannot be considered as finally settled. If a dose of phenol be added to manured soil, it produces at first a slight fall in the numbers of bacteria followed by a very rapid increase, the numbers sometimes reaching astonishing proportions. This quick rise does not take place, nor does the phenol disappear so rapidly, in soil from which the phenol bacteria are absent. The bacteria which are involved in this great multiplication are all of the Pseudomonad type of phenol-destroying organisms. There is thus reason to suppose that this is the type of organism which is of chief importance in the soil. On the other hand, the increase in the organism does not begin until about half the added phenol has disappeared, as can be seen from the chart (Fig. 3). There is still the possibility, then, that another group of micro-organisms that are not revealed by the counting technique at present employed may be attacking the phenol. The work on these bacteria is not, however, as yet completed, so that a full account of it cannot be given, but will appear elsewhere in due course.

The addition to the soil of such organic antiseptics as these we are considering produces an important effect beside that of destroying plant pests. In normal soil not treated with antiseptics, the bacteria which produce available plant food are in a state of equilibrium with the population of soil protozoa. It has been

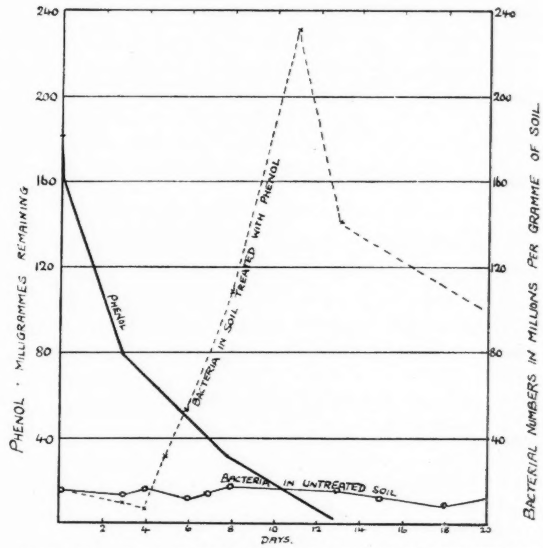

FIG. 3.—INCREASE IN NUMBER OF BACTERIA IN SOIL TREATED WITH PHENOL.

found by the Protozoology Department at Rothamsted that, in a field soil, increases in the numbers of actively feeding amœbæ are accompanied by decreases in bacterial numbers, and vice versa. Now, the addition of a mild antiseptic to the soil disturbs this equilibrium between Protozoa and Bacteria, enabling the latter to increase. Thus Russell and Hutchinson found in 1909 that the addition of toluene to soil caused an increase in bacterial numbers and a corresponding increase in ammonia and nitrate available to the plant as food. It is thus possible to increase the fertility of the soil by the addition thereto of a mild antiseptic.

The study of the effect of adding these organic antiseptic compounds to the soil is therefore of importance, not only with a view to their use for destroying soil pests, but also because it promises to throw light

on the balance of activities between the various groups of soil micro-organisms, and there is reason to believe that this balance is a fundamental factor in the fertility of the soil.

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The Franco-Russian Alliance

By R. B. Mowat

Fellow of Corpus Christi College, Oxford

THE alliance between France and Russia (1894 to 1917) was, throughout its duration, even more of a European mystery than the famous *Triplice* of Germany, Austria, and Italy. Although the documents of the Triple Alliance were not published until 1919, careful observers (like M. Herbette in Albin's *Grands Traités*) were able to make surprisingly accurate guesses or inferences. With regard to the Franco-Russian Alliance nearly all the inferences made by historians and journalists turned out to be wrong. Meanwhile the lips of the very few French and Russians who knew the facts remained absolutely sealed. It was not until the War and the Russian Revolution had put an end to the Franco-Russian diplomatic system that the French Government, in order to disprove the misrepresentations of writers and speakers, published the facts in an official Yellow Book.

The makers of the Franco-Russian Alliance were M. de Giers on the Russian side, and M. Ribot and M. de Freycinet on the French side. The object of these statesmen in framing the Alliance is fairly clear: it was that their respective countries might live in security. Nobody could seriously bring forward the charge that the Franco-Russian Alliance aimed at attacking anyone; for the Alliance endured so long, and was supported by so many different Ministries, one after another, in Russia and in France. An aggressive alliance can be made for a particular time and object; but an alliance which goes on year after year, as it were indefinitely, cannot by the nature of things be meant to attack anyone.

From 1872 to 1894 France stood alone and was practically at the mercy of Germany. She was really only protected by the common sense and moderation of Bismarck and his school, and by the public opinion of Europe. But France could not permanently rely on these things. In 1875 Bismarck became alarmed at the apparent revival of France and appears to have been on the point of declaring a war, which France would probably have totally failed to resist. In this instance war was actually averted by the friendly intervention of the British Foreign Office and Russian Chancellery.

In the early 'nineties, France had attained a position in Europe which enabled her to offer considerable inducements to Russia, in order to make an alliance. Russia required capital for railways. France wanted military security. Both Powers were interested in maintaining European peace, but Russia seemed to be so strong that nobody thought she required France's military help.

The Tsar Alexander III, like his father, Alexander II, was a peaceful man. But it was not the Tsar alone who counted; it was the vast bureaucratic machine through which Russian policy had to be administered. At the head of this bureaucracy in the 'nineties was M. de Giers.

Since the year 1882, on the retirement of the aged Gortchakoff, M. de Giers had been Russian Minister of Foreign Affairs. He was a tremendous worker. He had mastered all the detail of the Chancellery; he was capable, silent, and self-effacing, and in no way tried to impose his views on the Tsar. Actually the views of Alexander and of his Minister of Foreign Affairs coincided: they both wanted peace, and the maintenance of the *status quo*. One of the good qualities of M. de Giers was that he did not allow his delight in the labour at his table in the foreign office to deter him from travelling—one of the most beneficent directions into which the activity of a really peace-loving Minister can be directed. M. de Giers was indefatigable in his visits to the Capitals of the Great Powers of Europe—to Rome, Paris, Vienna, Berlin. Towards the idea of a military alliance with France he appears not at first to have been particularly favourable; but after conversations between himself and M. de Laboulaye, French Ambassador at St. Petersburg in 1891, he became convinced that a Franco-Russian alliance could be made to contribute to the stability of Europe.

The First Advances

The documents which have been published by the French Government trace the formation of the momentous alliance from the summer of the year 1891. The first important document in the collection is a letter,

dated August 21, 1891, from M. de Giers to M. Mohrenheim, Russian Ambassador at Paris. This letter calls attention to two recent events; the first was a series of conversations at St. Petersburg between M. de Giers and M. de Laboulaye (who was actually on the point of retiring from the Embassy at St. Petersburg to give place to M. de Montebello). The second fact was the supposed (and, as it is now known to be, *correctly* supposed) renewal of the Triple Alliance (see DISCOVERY for December 1922, p. 316).

In view of these facts, M. de Giers thought it advisable that France and Russia should "define and perpetuate the *entente cordiale*" which united them. He therefore made two suggestions: namely, that the two Governments should agree (1) to "deliberate in concert upon all questions of such nature as to put the general peace in jeopardy"; (2) "to act in concert upon those measures which the realisation of that eventuality would make it necessary for both Governments to adopt immediately and simultaneously."

This letter, when passed on by M. Mohrenheim to M. Ribot, French Minister of Foreign Affairs, elicited an answer on August 27, 1891. This answer states that the points in M. de Giers's letter had been "previously contrived and formulated by common agreement of the two Cabinets" (of Paris and St. Petersburg). The *entente* of France and Russia was therefore to be made more specific, so as to become something of the nature of an alliance. M. Ribot accordingly accepted the two suggestions contained in M. de Giers's letter of August 21, and concluded by saying that the problems arising out of this closer union would have to be confided to the "practical study" of "special delegates."

The result of this practical study appeared almost exactly a year later when, on August 18, 1892, the Russian Chief of Staff, Obroutcheff, and the French Sub-Chief of Staff, Boisdeffre, signed a Military Convention at St. Petersburg. The preamble stated that:

> France and Russia, animated by a common desire to preserve the peace, and having no other end in mind than to ward off the necessities of a defensive war provoked by an attack of the forces of the Triple Alliance against either of them, have agreed upon the following provisions.

The main provisions were that if France was attacked by Germany (or by Italy supported by Germany), Russia should come to her aid; and that if Russia were attacked by Germany (or by Austria supported by Germany), France would come to her aid. The two Powers were not to conclude a separate peace. The Convention was to have the same duration as the Triple Alliance. This Convention was "definitively adopted in its present form" by exchange of letters between M. de Giers and M. de Montebello (French Ambassador at St. Petersburg) on December 27, 1893, and January 4, 1894.

M. Delcassé's Part

The next change in the Franco-Russian Alliance comes with the period of M. Delcassé as *Ministre des Affaires étrangères* (1898–1905). M. Delcassé made the aim of his public life to assure the safety of France. This he aspired to do by drawing the alliance with Russia closer, and by arranging either an alliance or "entente" with Great Britain.

In a letter of August 12, 1899, to President Loubet, Delcassé pointed out the weak spot in the existing Franco-Russian Alliance: the clause concerning duration which limited the Alliance to the duration of the Triplice. If, for instance, wrote M. Delcassé, the Austrian Empire should break up at the death of Francis Joseph, the Triplice would dissolve and with it the Franco-Russian Alliance: "born of the Triple Alliance, it would vanish with it."

> "What would happen," asked M. Delcassé, "if Austria were threatened by a dismemberment which, perhaps, is after all desirable, which perhaps might be countenanced and which, in any case, one might become anxious to turn to account? What could be more capable of compromising the general peace and of upsetting the balance between the European forces? And what situation, furthermore, would deserve to find France and Russia, not only united in a common plan, but ready even for its execution? Now it is just at the precise moment when the military convention should work, that it would cease to exist: born of the Triple Alliance, it would vanish with it. That is a deficiency which has constantly troubled me since I became Minister of Foreign Affairs."

M. Delcassé had already discussed this with Count Muravieff (Russian Minister of Foreign Affairs who had succeeded M. de Giers) at Paris in October 1898. The visit of the Russian Foreign Minister had been returned by Delcassé, who arrived at St. Petersburg on Friday evening, August 4, 1899. On Sunday, August 6, M. Delcassé had breakfast with the Tsar Nicholas II at Peterhof. Nicholas commented with esteem and approval on Delcassé's judicious conduct in the last Franco-British crisis (the Fashoda affair). The two statesmen then discussed the Franco-Russian Alliance: "I revealed to the Emperor my belief and apprehension that the Alliance would be disarmed in case one of those very events should arise in view of which it was formed."

The Tsar admitted the reasonableness of M. Delcassé's argument.

> At that moment I took the liberty of submitting to the Emperor the draft of a declaration which I had drawn up this morning. In it the arrangement of 1891 is confirmed; but the scope is singularly extended.

The Tsar was inclined to agree that his own idea was the same as M. Delcassé's. He called in Count Muravieff, who was waiting in attendance in another room.

> An understanding already existed between the Minister of Foreign Affairs and myself on the fundamental basis of the plan. It was decided that the new arrangement, of which the contents and the very existence should remain absolutely secret, should be established undeniably in the form of letters which Count Muravieff and I would exchange. (Delcassé to Loubet, August 12, 1899.)

The "new arrangement," which, as M. Delcassé said, "singularly extended" that of 1891, was to make the Military Convention endure as long as the diplomatic agreement.

As originally made in 1891, the Franco-Russian Alliance consisted of (1) a diplomatic agreement for deliberation and action in concert when the general peace was in jeopardy; and (2) a military convention, to endure as long as the Triple Alliance. But now (August 9, 1899) by exchange of letters between M. Delcassé and Count Muravieff it was agreed (1) "to confirm the diplomatic arrangement formulated in M. de Giers's letter of August 21, 1891," and (2) to "agree that the draft of the military convention . . . shall remain in force as long as the diplomatic agreement concluded to safeguard the common and permanent interests of the two countries."

This was not quite all. The new arrangement extended the *scope* of the alliance. In 1891 the two Governments had agreed to "deliberate in concert upon all questions of such nature as to put the general peace in jeopardy." But in the letters of August 9, 1899, they declared, in the preamble to the new arrangement, their motive to be the maintenance of "the general peace and the balance between the European forces."

From the published documents it has become perfectly clear that the specific and the defined object both of the Triple Alliance and of the Franco-Russian Alliance was the maintenance of the *status quo* in Europe. If that *status quo* came to be threatened by the probable or imminent dissolution of the Austrian Empire, the Franco-Russian alliance was to ensure that out of the ensuing settlement, the territorial weight of the Great Powers should still be kept in balance.

Thus the *Triple Alliance* was meant to preserve the Austrian Empire. The *Franco-Russian Alliance* came to mean that, in the eventuality of the dismemberment of the Austrian Empire, something like the previously existing balance of power in Europe should ensue or be maintained. Therefore, each in their own way, the Triplice and the Franco-Russian Alliance aimed at peace. That they failed to ensure peace shows that it would be better if the system of separate diplomatic groupings could be replaced by a system of general diplomatic grouping in the League of Nations.

[NOTE.—The most important documents of the French Government Yellow Book have been translated and printed by the Association for International Conciliation of New York, U.S.A., in its publications for the year 1919, vol. i. It is from this source that the extracts given in the present article have been taken.]

Invisible Light

Its Physiological Effects and Practical Applications

By J. S. Dow

IT is common knowledge that the portion of the spectrum that we recognise as visible light forms only a "special case" of electrical waves. Just as a wireless receiver can be tuned with a maximum response to a certain wave-length, and a diminishing sensitiveness to the waves on their side of this maximum value, so the eye is most sensitive to the yellow-green rays in the visible spectrum; and the luminosity becomes less as we approach the red on the one side, and the violet on the other. Indeed, the curve showing the sensitiveness of the eye throughout the visible spectrum and the corresponding curve connecting response and wave-length of a wireless receiver resemble each other very closely; this has led some observers to conjecture that the light-perceiving apparatus in the human eye has much in common with a detector of electro-magnetic waves, such as that used in wireless telegraphy.

On either side of the visible region of the spectrum there are radiations which are non-luminous, but may yet have an important influence on the human body, and possess important industrial applications. As we pass from the limit of visible red to the "infra-red," radiations with a wave-length greater than that of "light," we find radiations which are distinguished mainly by their heating effect. As the writer's previous article[1] indicated, such radiation forms a considerable proportion of the energy emitted by most incandescent illuminants. Not a great deal is known regarding

[1] "Artificial Light—its Production and Application," DISCOVERY, February 1923, p. 44.

its physiological effects. Medical heat-baths, in which the patient stands in a cabinet surrounded by a mass of incandescent lamps, have been devised, and the ordinary electric radiator emits almost exclusively rays of this nature. Common experience suggests that the infra-red radiation present in most artificial illuminants has no material prejudicial effect on vision, provided the sources are not brought too near the eyes and are used discreetly. But continual exposure of the eyes to glowing masses at close quarters is doubtless bad, and the cataract that is somewhat prevalent amongst glassworkers and others who work in close proximity to incandescent material has been ascribed to this cause.

Much farther down the scale we come to the electromagnetic waves used in wireless telegraphy and telephony, and between there exists a wide range of infra-red radiations of whose properties little is definitely known.

human body furnishes an appreciable amount of heat, instruments which can measure very small quantities of heat could be used to detect the approach of an enemy at night. It is stated that by this device men were easily observed at a distance of 6co feet, and that a person lying on the ground 400 feet away was detected unerringly as soon as he lifted his head above the ground. Thus enemies creeping towards the trenches in the dark could be noted and a warning given. The method is also stated to have found some use in detecting the approach of hostile aircraft, and also as a basis of secret signalling. Experiments on the use of rays at the other extreme end of the spectrum, the ultra-violet, for secret signalling have also been made by the U.S.A. Army, and no doubt much work of a similar nature was also done for the British forces.

The most striking effects of ultra-violet light are met with in mountainous regions. These rays are

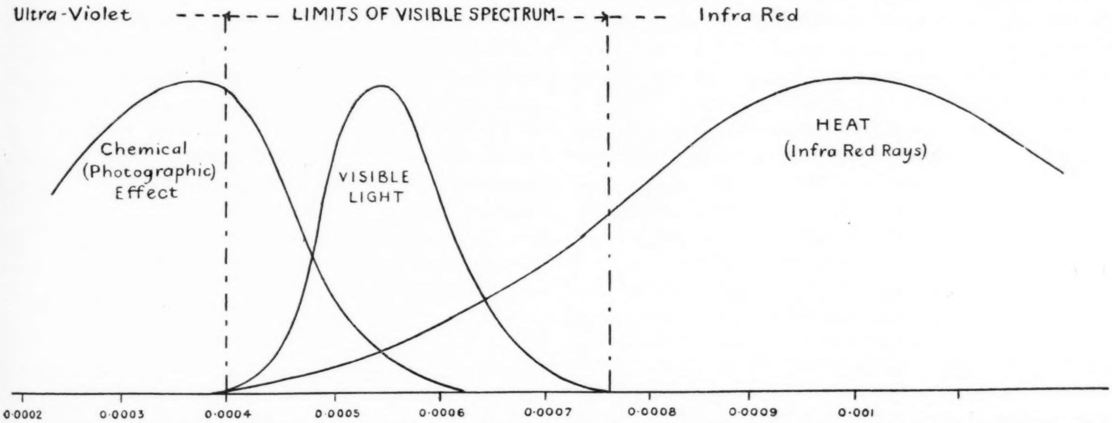

FIG. 1.—SHOWING ROUGHLY THE DISTRIBUTION OF HEAT, LIGHT, AND CHEMICAL (PHOTOGRAPHIC) EFFECT THROUGHOUT THE SPECTRUM.

The three effects of radiation in the visible and adjacent parts of the spectrum with which we are most familiar are heat, light, and photographic effect. These are distributed roughly in the manner indicated in Fig. 1. Interest centres chiefly on the invisible rays of wave-length shorter than the extreme violet—the "ultra-violet" which plays a considerable part in promoting chemical action as illustrated by the effect on the ordinary photographic plate.

Apart from their use as a curative agent, or for heating dwellings, infra-red rays adjacent to the spectrum have not as yet found many practical applications. But a highly interesting application of such rays occurred during the war. It occurred to several investigators connected with the U.S.A. Trench Warfare Research Division [1] that, as the

[1] *Physical Review*, August 1919.

rapidly absorbed by the earth's atmosphere—so much so that experimenters with rays of very short wave-length have found it necessary to cause them to pass their instrument through an evacuated glass tube. In the rarefied atmosphere at high altitudes the effect of these rays, accentuated by reflection from the snow, is very evident, and mountaineers now habitually use goggles to protect their eyes, and a mixture of lanoline and pigment to cover their skin. The influence of altitude is well shown in the accompanying diagram, based on Professor S. P. Langley's observations at the base and the summit of Mount Whitney in the Sierra Nevadas, 15,000 feet high.

Light Sources and Ultra-violet Light

Although the great majority of artificial sources of light, which depend on incandescence, furnish little

ultra-violet, there are certain sources which are relatively rich in this radiation. Amongst these may be mentioned certain arc lamps having carbons cored with metallic materials which impose ultra-violet lines over the ordinary spectrum. Such sources have been used in kinema studios, where the richness in ultra-violet light is useful on account of the enhanced actinic effect, and cases of temporary injury to eyesight of actors have been recorded. A committee operating under the Ministry of Health recently considered this matter very fully, and came to the conclusion that the liability to injury could be easily avoided if the sources were properly screened. Experts seem to agree that the use of very powerful unscreened lights is not necessary, except possibly in rare cases, in the kinema studio; and that the most pleasing effects are obtained when the light is softened and diffused by reflection or transmission through translucent materials giving conditions approaching more nearly to daylight.

Arc-welding is another process where injury to the eye through ultra-violet light must be guarded against. In this case the richness in ultra-violet is due to the same cause—the mingling of metallic materials giving strong ultra-violet spectra, with the carbon. When a carbon arc is used to weld or cut iron plates, the spectrum of iron, containing many prominent lines in the ultra-violet, is superimposed over the continuous spectrum of the glowing carbon. Operators must accordingly protect their eyes and skin by the use of goggles and masks.

So far as can be ascertained, the great majority of injuries that have been caused by ultra-violet energy are transient. The sufferer frequently feels no ill-effects at the time, but wakes up in the night to find his eyes in a most inflamed and painful condition. This passes off in due course. But it is conceivable that prolonged exposure to excess of ultra-violet light may have serious permanent effect. For example, cataract has been attributed to this cause, and it is a fact that albuminous transparent material can be almost instantaneously coagulated by exposure to these rays. An interesting research by Burge [1] leads to the suggestion that certain conditions of health, leading to an undue proportion of salts of calcium, magnesium, and sodium in the eye-lens, may accentuate the tendency of ultra-violet rays to cause cataract. This may explain why a few persons frequently exposed to these rays suffer, while the great majority escape.

It should not be assumed that ultra-violet light is necessarily prejudicial. In this case, as in many others, what is harmful when indiscriminately applied may be beneficial when used with discretion. Exposure of the body to ultra-violet light has proved of great value in the treatment of various skin diseases; the rays which inflame the living tissue may kill a parasitic growth. Of the special sources used for this purpose, interest attaches to the mercury vapour lamp with a quartz glass tube, probably the richest of all artificial sources in ultra-violet light. Ladenburg has estimated that as much as 30 per cent. of the radiation of luminescent mercury is located in the ultra-violet light, and the quartz tube allows these rays to pass unimpeded. But in addition to these therapeutic uses, the exposure of the body to the ultra-violet energy derived from the sun is believed to be beneficial to the adult, while in the case of children it has a special value. Several infantile ailments are closely associated with access of light. Rickets is now regarded as a "disease of darkness." It was formerly thought that poor diet was the determining factor. Then it was found that the disease was contracted mainly by children in large towns who were little exposed to sunlight; also that in some cities in India the children of the very poor who lived on an inferior diet but constantly played in the open air did not contract the disease, whereas the children of wealthy Hindoos who were well fed but lived an indoor, secluded life were very prone to it. Sir Henry Gauvain, in recently referring to these facts, mentioned that exposure to sunlight formed a regular feature of the treatment in the Treloar Cripples' Homes at Hayling Island, and it has recently been found that exposure to artificial sources rich in ultra-violet light can advantageously replace sunlight during unfavourable weather.

The Fading of Colours

Let us now turn to some effects of ultra-violet energy on inanimate things. One of the most striking effects due to this form of radiation is the fading of colours. The ultra-violet rays are potent in causing chemical action, of which photography has already been mentioned as a familiar example. The fading of objects when exposed to sunlight is well known. In certain cases, for instance in the case of priceless and unique specimens in museums, it forms a serious problem. Some interesting experiments on this point were recently summarised by Sir Sidney Harmer, Director of the Natural History Section of the British Museum, in a lecture before the Royal Society of Arts. In general natural colours are more permanent than artificial pigments. Artists have to be discriminating in their use of colours, for there are many pigments which fade appreciably after only a few days' exposure to strong sunlight; an extreme instance of instability is to be found in the purple copying ink used on ordinary typewriter ribbons, which fades noticeably after a few hours' exposure, and ultimately may be made to disappear entirely. Even delicate natural

[1] *Electric World*, April 10, 1915.

colours, such as those in the wings of moths and butterflies, show distinct fading after some weeks of exposure, though the fur of some animals has been found to resist action for more than a year.

It is believed that the chemical action inducing fading of colours demands three chief conditions, the presence of ultra-violet light and oxygen and moisture. Thus if an object could be kept perfectly dry and enclosed in a vacuum, there should be no fading, but in practice this condition is rarely realisable. While it is probable that visible light may also play a subordinate part in causing fading of colour, it seems to be well established that the effect is mainly due to ultra-violet rays. Indeed, such sources as the quartz-tube mercury vapour lamp have proved of great value in enabling dyers and carpet manufacturers to test the permanency of their colour rapidly and scientifically, without being dependent on the capricious periods of sunshine characteristic of the British Isles. In the United States a special form of testing lamp for this purpose has been designed.

The most hopeful method of avoiding fading, therefore, is to exclude ultra-violet rays so far as possible. Sir Sidney Harmer has experimented with various glasses, more or less opaque to such radiation. Unfortunately the glasses that are most successful in this respect appear to have a distinct yellow coloration which would interfere with the observation of the colours of specimens—even if such glass could be used in sufficient quantities to enclose large objects. Another drawback is that the glass diminishes fading but does not eliminate it. The process is slowed down but is still cumulative, and the pitiless destructive force continues. Sir Sidney Harmer's experiments, however, suggest another interesting conclusion—that the "fading effect" of light from electric incandescent lamps is distinctly less than that of diffused daylight, and very considerably less than that of direct sunlight. It is worth consideration, therefore, whether objects having fugitive colours might be housed in rooms illuminated solely by artificial light—possibly by "artificial daylight" of the type described in the writer's former article, which would enable colours to be correctly revealed.

Other chemical effects of ultra-violet light have been applied for industrial purposes for the tanning of leather and in processes of sterilisation where the rays are designed to destroy injurious bacteria. But perhaps their most interesting effect is to be found in the phenomena generally described as "fluorescence," i.e. their conversion into visible light. By using an arc between tungsten electrodes, a quartz-tube mercury vapour lamp, or other source rich in ultra-violet rays, in conjunction with a plate of Chance's special glass, we can obtain ultra-violet light almost completely free from visible rays. This "dark beam" produced by a quartz lens is itself invisible. But when it falls on certain objects they exhibit "fluorescence" and themselves become luminous. Many substances have this property in a greater or lesser degree. Certain forms of zinc sulphide fluoresce with a vivid green, calcium sulphide with blue light; other materials can be found to give us red and other hues, so that it is possible to paint with them a picture, indistinguishable by visible rays, but glowing in natural colours when the ultra-violet energy is substituted.

Many crystals and precious gems have the same property. At a meeting of the Illuminating Engineering Society it was recently shown that by this means false stones could be distinguished from genuine ones, Indian pearls from the cultured Japanese variety, and South African diamonds from Brazilian ones. One can also prepare fluorescing solutions, and it has been suggested that by this means we could provide an additional safeguard in the preparation of bank-notes. They could be impregnated with fluorescing material leaving no traces in visible light, but showing a luminous pattern—a species of secret watermark—under the ultra-violet rays.

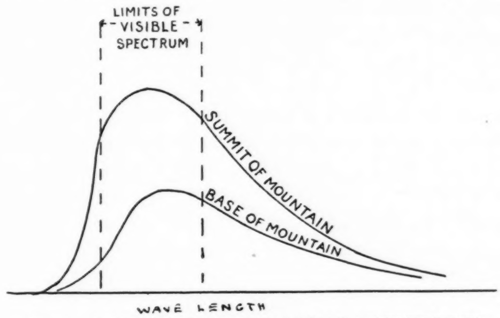

FIG. 2.—SHOWING THE DISTRIBUTION OF ENERGY IN SUNLIGHT AT THE BASE AND AT THE SUMMIT OF A MOUNTAIN 14,000 FT. HIGH.

(Based on Langley's experiments.)

Not only is the total radiation at the summit far greater, but the proportion of the ultra-violet is much increased, owing to the diminished absorption by the atmosphere.

Fluorescence and Economical Lighting

Finally, it may be asked whether the phenomena of fluorescence could not be applied to produce a highly efficient luminous source yielding light without heat. The idea is of course familiar to scientists. A correspondent of DISCOVERY[1] draws attention to an extract from a work entitled *What is Electricity?* by John Trowbridge, published as far back as 1897, and mentioning some experiments of Ebert.[2] This investigator is quoted as having utilised an electric discharge in an exhausted glass globe, coated with fluorescent materials,

[1] Mr. C. G. Bishop. [2] *Ann. der Physik und Chemie*, No. 9, 1894.

mainly zinc sulphide. When a high-tension discharge was applied to the apparatus the zinc sulphide became luminous, doubtless owing to excitation by ultra-violet rays. This experiment is of historic interest (although Ebert's experiments would appear to have led to no practical development in this form of light-source) in view of the results stated to have been obtained by a French scientist, M. Risler. Of these experiments we must await further technical details. According to accounts published in the daily press Risler utilises a discharge through tubes (about 6 yards long) containing rarefied gases and coated with a fluorescent mixture having zinc sulphide as its main base. The combination is stated to have proved highly efficient.

Theoretically the production of a cold light in this way appears promising. But although the presumable absence of heat-radiation is a favourable factor, there are other difficulties. We have still to determine what proportion of the electrical energy applied to produce the discharge appears in a form to which the fluorescent material is responsive. Assuming that the efficiency in this respect is high, we have next to ascertain what candle-power is attainable from such materials when excited. Experience of ordinary phosphorescent phenomena does not suggest that a very powerful source of light could be obtained by this means. Phosphorescent and fluorescent effects, though striking when observed in a dark room, are usually of very feeble intensity in comparison with incandescent sources. The "ageing" and gradual failure of the material to respond to excitation would also need study. In addition phosphorescent materials almost invariably yield light of a peculiar colour—for example, a few vivid blue or green lines in the spectrum, which would not be very satisfactory for ordinary purposes of illumination, though possibly the difficulty might be overcome to some extent by a combination of materials.

Most experimenters with fluorescent substances would probably agree that there are formidable difficulties to be overcome in producing a commercial light-source based on this method. Nevertheless, this constitutes a fascinating line of investigation, and further details of Risler's experiments will be awaited with interest.

The First Book of Patents

By S. and J. Harrison

"THIRTY-FIVE thousand applications were granted in 1922," the blue-coated official who sits by the door of the Patent Office library in Chancery Lane informs the curious. If one is impelled by the information to discover how long mechanical invention has been a popular pastime, and what its beginnings were, the red file marked "Patents Nos. 1 to 40—1617–1627" provides entertaining reading.

The first three specifications in the file are not numbered, and the earliest of them was granted in February 1611. It reads as follows:

> Metallica; or the Treatise of Metallica Breafly comprehending the doctorine of Diuerse New Metallical Inuentions. But especially How to Neal, Malt, and work all kinde of Mettle, Oares, Irons, Steeles with sea-coale, pit-coale, earth-coale and Brush Fewell. also a Transcript of His Maiesties letters patent of priuledge, Granted unto Simon Sturteuant for the said Metallical business for one & thirty years.

This patent, like all the early ones, was, in its way, quite a literary work. It was not written in the terse, technical language which the patent-agent uses in the drawing-up of a modern specification. Classical allusions and Biblical quotations were frequent. There were occasional references to the Saints. Simon Sturtevant, for instance, starts his specification thus:

> Gentle Reader, I am not ignorant how they that are willing to apprehend and assist new buisness are desirous to be satisfied on these points. First concerning the perfect and exact knowledge of the inuention wherein they are to deal and negociate, for as the common prouerbe saith:—"Ignoti nulla cupido." . . .

Mr. Sturtevant, however, must have got into trouble, as the next patent shows.

> But not that which was published by Mr. Simon Sturteuant upon his Patent, which is now, by order, cancelled and made voyd, by reason of his standing out-lawed at the time of the grant, and so still continuing and his neglect and not performance of the workes. Whereupon Priuledge By Patent is granted by the King's most excellent Megesty to John Rovenson Esqr., for the making of iron and other materials with sea-coale, pit-coale &c., for one and thirty years. . . .

The third volume in the file, and the first to receive a number, was granted in 1617 to Avon Rathburne and Roger Burges "for a terme of twentie and one years" by "James—by the grace of God Kinge of Englande, Scotland, Fraunce and Irelande." Although the words "Englande" and "Irelande" are each here spelt with a terminal "e" they are written modern fashion during the course of the specification itself. The patent was concerned with the printing of maps and plans, and the following quotation shows the patentees to be full of a pride of city.

. . . to the great honor and renowne of those princes in whose domynions they are, and that our cittie of London, being chiefe and principall in this our Kingdome of England there hath never been made or taken any true or perfecte descripcon, but false and meane drought cutt out in wood, and soe dispersed abroade, to the great disparagement and disgrace of soe famous and worthie a state :

The closing of a sentence with a colon is only one of the more obvious curiosities of punctuation to be found in these early patent specifications.

In the same year, John Jasper Wolfen and John Miller were granted a patent (No. 4) for protecting armour and arms from "rust or canker."

> A certayne oyle or composicon of oyles wherewith to keepe Armors and Armes from Rust, Canker or the like Meanes of perishing or decay farre exceedinge the ordinary wayes or Meanes nowe or heretofore Vsed in that behalfe :

This patent, it seems, could more fairly be described as a wide monopoly, for not only are the terms delightfully vague, but the patentees could collect 40*s.* on each quart of oil used that infringed their rights. They were legally entitled to search any premises suspected of harbouring such oil, provided that they were accompanied by a constable. And all these rights cost only 40*s.* per year. It seems that the two Johns are the spiritual fathers of the panacea mongers who infest commerce to-day. They made their claims but said nothing concerning the composition of their product.

John Jasper Wolfen did, however, patent an invention later on (No. 40), which, though last of the patents in the file, is far from being the least important. It refers to :

> . . . a Newe invencon for the making and pparing of ctaine Stuff and Skynns to hould out Wette and Rayne. . . .

In the specification of what is probably the father of the raincoat appear these words :

> . . . a commodity which he affirmeth is very likely to be of verie good vse and benefitt to the comonwelth. . . .

Wolfen must surely have had a grievance against "Wette and Rayne."

Another gentleman whose thoughts took the same line was one William Bale, "Gouldsmith of London" (No. 32). He patented

> . . . certen compounded stuffs and waters called or known by the Name of Cement or Dressing for Shippes. to preserven them from being burned owing to a fight at sea allso to protect their hulls from Sea-worme and Barneacle. . . .

We are still looking, in 1923, for the perfect anti-fouling dressing for ships' hulls. Patent No. 5 is of interest for the following naïve personal reference which it contains :

> . . . to Thomas Murraye Esquire, secretarie to our deare sonne Prince Charles. . . .

The first truly mechanical invention—if one excepts an invention for raising water and ploughing land without oxen or horses (the patentees do not say how !)—was patented by John Dickson (No. 16—1619). It was a "Backstall or Back frame" for bedridden invalids. The specification informs us that Mr. Dickson noticed that persons who lie in bed for any length of time are liable to suffer from "distemper." The invention was presumed to overcome this.

Only one other really important invention is to be found in this file. It was granted to Edward Knappe in 1625 (No. 31). He patented a most revolutionary type of coach and harness. The vehicle was to have a variable track, so that the wheels could be set apart at the distance most suitable to whatever road was being traversed. Even if Knappe had refrained from making any reference to the vile surfaces of some of the roads of his day, the mere existence of the patent is surely sufficient testimony to their condition. The body of Knappe's coach was slung between springs, and possessed an apparatus whereby the driver could stop the rear wheels from rotating without leaving his seat. The inventor made wide claims for his vehicle, but when one considers that this may have been the first design including both springing and a proper braking system, they do not seem to be unduly exaggerated.

Two thoughts arise when one has finished reading the red file. Firstly, why is it that modern manufacturers do not name any of their models after those obscure inventors who, maybe, are the true founders of their several industries ? And, secondly, what would Knappe, Wolfen, and the others think of tanks and submarines, of aeroplanes and wireless ?

Curiosities of Science

TWICE a year the Royal Society holds what are known, rather quaintly, as Conversaziones. On these occasions distinguished workers in many varied fields attend to give demonstrations of some striking example of their recent discoveries or inventions, for the benefit of the inexpert.

At the Conversazione held on May 16 at Burlington House there were in all thirty-seven different exhibits. They were for the most part admirably selected—and the selection of a subject capable of simple demonstration,

and at the same time of striking interest, is not by any means a simple matter. For instance, a very large instrument for estimating the heating powers of gas—"The 'Boys' Integrating and Recording Gas Calorimeter"—while fascinating in its intricacy, was perhaps of too complicated design to be understood save by the expert, after careful study.

Great interest was taken in a "stream-line filter" exhibited by Dr. Hele-Shaw, F.R.S. Everyone is familiar with the waste of time involved in filtering fluids containing suspended matter by ordinary means. Yet filtration is a process which is essential every moment in laboratories. In this new filter, a most simple device is employed with extraordinary success. Holes about half an inch in diameter are punched through a series of sheets of paper—the eventual effect being rather as if one had pushed a cheese scoop through a magazine several times. The dirty water is then forced through these holes by a pump, while the sheets of paper are forced together with a variable strength. The water is only allowed to escape between the leaves of paper, and since that space is exceedingly small, all solid matter remains behind in the large punched-out spaces. Even a dye, such as methylene blue, if put through the filter, comes out colourless, and it must be remarked that this is in no sense the effect of what is called "adsorption"—a physico-chemical process by which a kind of combination between dye and paper takes place—but a true filtration, or mechanical removal of suspended matter.

Mr. John Walton, of the Botany School, Cambridge, also selected a simple and yet most interesting demonstration. Fossil plants, while common enough, are rather disappointing to the botanist, since they show little detail. In Mr. Walton's new method of examination, an impression of the fossil is taken on a gum known as balsam. The rock is then dissolved off with acid. The results are amazing. Every tiny detail of hairs, cells, and water-conduction systems of the leaves is revealed with absolute clearness, and, instead of a faint impression on a rock, we are face to face with what appears to be a living plant, which grew and faded away many million years ago.

Mr. Walter Heape, F.R.S., showed a series of photographs, taken at the rate of from 500 to 5,000 per second. The breaking of a glass vacuum-tube by a hammer was one example—the complete break-up taking only a twentieth part of a second. The tube seemed to bulge inward first at the point of impact, and then the part of the tube opposite to that point bulged outwards, and broke in a fine powder; finally the process of destruction extended all over the tube. A solid rubber ball was also followed in its course from a gun to a steel target—a process which, with the rebound, occupied only one-fortieth of a second. It assumed the most complicated shapes during its adventures—varying from a flat disk, when it hit the target, to an egg with a flat base when it bounced off. Intense illumination is essential for these experiments—two searchlights were employed in one instance—and the cinema machine was an immense erection, operated by electricity.

Much has been heard of late concerning the transplantation of the heads of water-beetles. Three specimens of beetles thus treated were shown by Mr. H. Graham Cannon—of the beetle *Hydrophilus* on which the head of a separate species, *Dytiscus*, had been grafted. In one case a dissection had been made, and it was shown that the gullet of the composite creature which resulted was continuous throughout. The further developments of this new investigation will be awaited with great interest. Skin grafting, bone grafting, and gland grafting have been performed for many years with success; but when we remember that a successful grafting of a head on to a new body involves the regeneration of nervous tissue—or at least appears to involve it—we are in touch with a really important question. It is well known that, in the human body at all events, if the spinal column is cut across there is never any regeneration. A nerve, on the other hand, will regenerate, although, as far as we know, there has never been a successful attempt to graft a nerve from another species on to a severed nerve.

A more intimate exhibit was that of the contents of a crocodile's stomach, which was, in the words of the catalogue, "a notorious man-eater." It lived in Africa, in the Tanganyika Territory, and its stomach contained a number of human bones, several metal bracelets, a bead necklace, and the quills of a porcupine. There must be several disadvantages in being a crocodile!

The National Institute of Industrial Psychology, under Dr. S. C. Myers, F.R.S., showed a number of examples of research work. There were investigations on the effect of improved illumination on the output of coal-miners, and a series of tests which were designed to select individuals entering engineering trades for their most appropriate tasks. They consisted of strips of wood of various sizes, which had to be grouped in pairs so as to make strips of equal length, geometrical figures which together made rectangles, and other more complicated devices. The results of these tests were in many cases surprising and valuable; for example, it is seen that there is never any relationship between accuracy of muscular control and muscular strength; moreover, the particular aptitudes discovered were independent of the general intelligence of candidates as tested by an examination in English.

Our only regret is that such demonstrations as this of the Royal Society are not open, more frequently, to the general public. They go a long way towards stimulating interest in the great advances of the present day.

R. J. V. PULVERTAFT.

Reviews of Books

The Nebular Hypothesis and Modern Cosmogony. By J. H. JEANS, M.A., F.R.S. (Oxford: Clarendon Press, 2*s.* 6*d.*)

Those of us who read seldom give the attention to lectures issued as pamphlets that is given to larger works bound in cloth. This is frequently a mistake. A lecturer with an audience to face, and a subject to describe

in a limited time, must necessarily put more of himself into his lecture than he would if he were merely expanding his ideas in the quiet of his study. For a lecture he must choose the right facts and ideas germane to his theme very carefully, describe things clearly, omit cumbersome details, avoid side-issues, and make the whole as plain and interesting as possible. These are precisely what the general reader likes a writer to do.

Dr. Jean's Halley Lecture is a case in point. It is an excellent example of semi-popular exposition. He gives an account of Laplace's nebular hypothesis, shows that it will not explain, as Laplace hoped it might do, the origin of our solar system, but that with a little modification it explains very satisfactorily the birth of stars from a nebula of hot rotating gas. Much of the lecture is concerned with this point. In the second part the lecturer discusses the formation of our solar system. Planets, he shows, are not evolved from a star as the star has evolved from a nebula. They are probably produced as the result of one star passing in its course sufficiently near to another permanently to affect it. Calculation shows that violent disturbance of this kind will be the lot of very few. In consequence systems such as the solar system " must be rare in the sky . they may be normal in the sense that the events which formed the planets out of our sun might have happened to any star ; but they are abnormal in the sense that such events have in all probability happened only to very few. Indeed, it is just within the bounds of possibility, although quite, I think, outside the bounds of probability, that our system is unique—that out of the two or three thousand million stars which people space, our sun may be the only one attended by satellites. To carry this train of thought one step farther, it is just possible, although again quite improbable, that our earth may be the only body in the whole universe which is capable of supporting life."

That is surely a highly interesting statement from modern science. And later Dr. Jeans expresses this thought in a different way. " We begin to suspect that life is not the normal accompaniment of a sun, since planets capable of sustaining life are not the normal accompaniment of suns. Astronomy . . . begins to whisper that [life] must necessarily be somewhat rare. Her suggestions, although still vague, seem to indicate that our terrestrial life forms a greater proportion of the sum total of all the life of the universe than we at one time thought."

Botany of the Living Plant. By PROF. BOWER, SC.D., F.R.S. Second Edition. (Macmillan & Co., 25*s*. net.)

Professor Bower's textbook, " framed on the lines of the annual course of Elementary Lectures on Botany given in Glasgow University for more than twenty years," was first published in 1919. The author is recognised as one of the leading authorities on that branch of Botany which is more especially concerned with the form and structure of plants ; by his intensive study of the ferns and allied plants he has done more than any of his contemporaries to provide trustworthy data which throw light on the relationships of certain families and on their relative position in the order of evolution. In his book, as one would expect, he has given an attractive picture of the plant kingdom from the standpoint of a botanist who thinks of a plant as a complex machine fitted by its structure for the manifold activities of a living organism. In the first edition it was thought by some reviewers that too little attention had been paid to the cell as the unit of plant structure. The living protoplasm of the cells is the seat of the innumerable chemical-physical phenomena which form the basis of life, and it is of the utmost importance that students should realise at an early stage in their career that a knowledge of the properties of the cell-contents is the first step towards an intelligent appreciation of the mechanism of plant life. The addition of a chapter on the living cell has added considerably to the value of the book. Other alterations are also improvements. The addition of a chapter on Evolution, Homology, and other subjects of fundamental importance draws attention to conceptions which are liable to be neglected in a book primarily concerned with supplying the raw material of botanical facts. It is clearly impossible, even within the limits of a bulky volume, to deal thoroughly with the different divisions of the plant-kingdom from the dual point of view of structure and function. Every teacher knows that one of his greatest difficulties is to decide what to omit. A course on elementary botany is merely an introduction ; the aim should be to illustrate fundamental principles, to enable a student to grasp essentials, and to awaken his interest in plants as living things. Professor Bower's treatment of the subject is both scholarly and interesting ; he is careful of detail and does not lose sight of its application to the major problems with which the biologist is concerned. In a general textbook for elementary students it is perhaps superfluous to include an account of many families of flowering plants, as the author has done in Appendix A. The important point is to give a student a general idea of the nature of a flower, to enable him to appreciate the range of floral structure within a family, and so to understand the meaning of a natural system of classification, and to teach him how to use a Flora in order that he may identify plants in the field. The more detailed systematic treatment of families of flowering plants is provided for in various books devoted to that branch of botany.

A. C. S.

A Perthshire Naturalist : Charles Macintosh of Inver. By HENRY COATES, F.S.A. Scot. Foreword by PROF. J. ARTHUR THOMSON and PROF. PATRICK GEDDES. (T. Fisher Unwin, Ltd., 18*s*.)

Mr. Coates describes the life-story of a poor but very remarkable Scotsman—rural postman, naturalist, and musician—who died at the age of eighty-two at the beginning of last year. Macintosh was the first-born of a hand-loom weaver—one of the kind you read about in Barrie's *Window in Thrums.* He tried saw-milling on leaving school, but an accident that maimed his left hand when he was nineteen led him to become a postman. His beat lay in the particularly charming countryside around his native village, Inver, a tiny place across the

Tay from Dunkeld in Perthshire. He held this post at a salary of less than forty pounds a year till he was fifty-one, when he retired on a pension of ten shillings a week. He did not marry upon either of these incomes. He was early imbued with a love of nature, and his calling and the countryside gave him excellent opportunities of using his talents. He was a bit of an ornithologist, a biologist, a meteorologist, and an archæologist; but most distinguished as a botanist. On these subjects he published no less than ten papers in the *Proceedings of the Perthshire Society of Natural Science*. He was particularly keen on fungi, and of the seventeen he discovered, four were new to science, and the remainder to Britain.

He was also interested in music. He collected old melodies, composed a few new ones, tried his skill at hymn-tunes, and, despite his maimed hand, could perform on the 'cello. " Fond of living things, perhaps birds and children most of all, of music and poetry, of wood-turning, of old things, of queer things like toadstools, of his microscope, and of the march of the seasons, he never had a dull moment. Of course, he made his discoveries of new creatures and new occurrences, of which anyone might be proud, but the man was bigger than all he did. . . ."

This I quote from the foreword. He was indeed a fine type of naturalist who made a success of his life in the true sense.

The book is, however, more than a mere biography of Macintosh. The opening chapters are taken up with a sketch of the topographical features and the past history of the region where his life was spent, and they throw light on the part which central Perthshire played in the history of Scotland. Next, the folk-lore of rural Scotland during the eighteenth and nineteenth centuries is dealt with, and many half-forgotten customs and incidents are recalled. The chapters which mainly record the results of Macintosh's researches give at the same time an interesting epitome of the folk-music and the natural history of Perthshire.

This is a book for Scots, for lovers of Nature, and for those who, like Edward Fitzgerald, realise that in the biographies of obscure persons there is more of interest than in any but the very finest novels.

The Spectroscope, and its Uses in General Analytical Chemistry. By T. THORNE BAKER, A.M.I.E.E., F.R.P.S. Second Edition. Pp. x + 208; 94 figures. (London: Baillière, Tindall & Cox, 1923, 8*s.* 6*d.* net.)

Mr. Thorne Baker has aimed at producing " an intermediate textbook which will connect the ordinary treatises on general physics with the modern advanced works on the spectroscope," but has only succeeded in writing a somewhat discursive survey of the various fields covered by modern spectroscopy, suited rather to the amateur than to the student. In spite of the sub-title, the analytical use of the spectroscope is not well described, and the practical instructions given are frequently inadequate. The theoretical discussions are elementary and not always lucid. Good features of the book are the illustrated descriptions of laboratory spectroscopes commercially obtainable, the sections on the choice and use of plates for spectro-photography, and the inclusion of many references to the original literature.

D. C. H.

[N.B.—Owing to a publishers' error, the price of this book was originally given as 7*s.* 6*d.*]

Some Questions of Phonetic Theory. Chapter VI. The Mechanism of the Cochlea. By WILFRID PERRETT, Reader in German in the University of London. (W. Heffer & Sons, Ltd., 2*s.*)

This little book is controversial and acutely technical. It attacks the theory of " sympathetic resonance " in the cochlea—the idea that those of us who hear have a kind of " baby grand " in either ear. In its irony and witty asides the book is more akin in style to a dialectic display in the *Classical Review* than to the duller but no less pertinent arguing in a magazine like *Nature*.

The Religion of Science. By WILLIAM HAMILTON WOOD. (Macmillan & Co., Ltd., 6*s.*)

It is difficult to understand for which class the professor of Biblical History at Dartmouth College, New Hampshire, has written this book. Theologians may agree that the science disclosed in it is all right, but they will never pass the theology, and biologists, without disputing the theology, will smile at the author's statements about evolution. The plain reader will be completely mystified by the quantity of miscellaneous information conveyed to him. The style, moreover, is both too allusive and too elusive. No, I am afraid this book will not do.

The Mathematical Theory of Relativity. By A. KOPFF, Professor of Astronomy at the University of Heidelberg. Translated by H. LEVY, M.A., D.Sc. (Methuen & Co., 8*s.* 6*d.*)

This book contains a clear exposition of the mathematical and physical foundations of Einstein's theory in the form of a course suitable for University students of mathematics and physics.

The Problem of Solution. A Tavern Talk between certain Chymists and Others. By STEPHEN MIALL. (Benn Brothers, 2*s.*)

This quaint, amusing, and, on the whole, good-natured pamphlet describes a conversation in the style of two hundred years ago on the subject of solution in chemistry between a Friend (representing the majority of chemists at the present day who believe in " ionisation ") and a Chymist (the Armstrong school which believes that part of the theory is untrue and other parts positively disproved). Friend is not entirely worsted, but he receives many knocks from Chymist, a tremendous talker, who is clearly out to win a dialectic triumph, and who is the type of arguer which makes reference to Mr. Dooley.

A student of chemistry will gain much interest in, and some information about, the facts of solution from this talk. It has an introduction by Professor H. E. Armstrong and it is followed by several critical letters.

Says Chymist: " I think the explanation these ionists give of solution, of electrolysis, of osmotic pressure and of chymical change is misleading and doing great harm

to the young students. Some day all these ideas and the jargon in which they are expressed will be out of date as the doctrine of phlogiston. That was a useful idea for a few years; it made people think." But with regard to the second sentence, how can Chymist or anyone else say that? The future *may* decide in favour of the theory of ionisation, and regard as very trivial indeed present objections to it. But who can say? Someone who argues very like Chymist attacked the disintegration theory of radio-activity twenty years ago. The theory stands now as it did then, but where are now the objections? It is they that lie on the dust-heap where "the elixir of life" lies dead and "phlogiston" rots.

The Phase-Rule and its Applications. By ALEXANDER FINDLAY, M.A., D.Sc., F.I.C. (Longmans, Green & Co., 10*s.* 6*d.*)

The fifth edition of this excellent work, the most popular among students of Sir William Ramsay's series of *Textbooks of Physical Chemistry*, includes the notable additions to the subject since the time of the last edition, 1914. These are principally in connection with heterogeneous equilibria. In consequence there has been much revision and addition. The sections on sulphur and phosphorus, for example, have been rewritten, and that on iron-carbon alloys has been drastically revised in the light of recent work. Graphical methods of representation, especially those suggested by Jänecke, have been expounded more fully here than in the earlier editions. And in other ways there are improvements which add to the usefulness of the book.

Maps and Survey. By ARTHUR R. HINKS, C.B.E., M.A., F.R.S. Second Edition. (Cambridge University Press, 12*s.* 6*d.*)

Maps and Survey, by the Secretary of the Royal Geographical Society, first appeared in 1913, when the author lectured in the department of Geography at Cambridge. The titles of its chapters then were Maps, Map Analysis, Route Traversing, Simple Land Survey, Compass and Plane Table Sketching, Topographical Survey, Geodetic Survey, and Survey Instruments. The book is now reissued with the original chapters as they stand supplemented with one containing a few necessary corrections and additions. To these have been added new chapters—A Further Chapter on Maps, Maps and Survey in War, and New Methods of Survey—so that the work might include a description of the very valuable advances made during the years of war, and be up-to-date.

The book is now one which students of geography may read for accurate information on the subject it describes. It is clear and comprehensive; the author is and has been in a position to obtain up-to-date information, and he is one who loves accuracy and carefulness of statement for their own sakes. The first of the new chapters describes matters recently under discussion at the Geographical Society, such as the international map on the scale one to a million, flying maps, and the spelling of place-names; the second gives an account of the work of "Maps" during the war—survey for artillery, flash-spotting, sound-ranging, etc.; and the third subjects like mapping from air photographs, and instruments for stereoscopic survey.

A Textbook of Ore Dressing. By S. J. TRUSCOTT, A.R.S.M., M.I.M.M. (Macmillan & Co., Ltd., 40*s.*)

An informed, comprehensive, and well-illustrated treatise on the subject by the professor of mining at the Imperial College of Science and Technology, the more valuable and useful because the author in his day has been a practical man. The dedication (in the first nine words of the Absolution in the Prayer Book) might, one reader at least thinks, have been expressed differently, or, better, since the book is on technology, omitted altogether.

Chemical Technology and Analysis of Oils, Fats, and Waxes. Vol. III. By DR. J. LEWKOWITSCH, M.A., F.I.C. Sixth Edition. Revised by GEORGE H. WARBURTON. (Macmillan & Co., Ltd., 36*s.*)

This volume completes the revised edition of Dr. Lewkowitsch's standard work of reference on the subject, and contains chapters on the technology of manufactured oils, fats, and waxes, and on the technology of waste oils, fats, and waxes, and the commercial products derived from them.

Books Received

(Mention in this column does not preclude a review.)

ANTHROPOLOGY AND ARCHÆOLOGY

The Ancient Egyptians and the Origin of Civilisation. By PROF. G. ELLIOT SMITH, M.A., M.D., Litt.D., F.R.S. New and Revised Edition. (London and New York: Harper & Bros., 6*s.*)

The Bakitara or Banyero. By JOHN ROSCOE. (Cambridge: at the University Press, 25*s.*)

SCIENCE

Aspects of Science. By J. W. N. SULLIVAN. (Richard Cobden-Sanderson, 6*s.*)

Great and Small Things. By SIR RAY LANKESTER, K.C.B., F.R.S. (Methuen & Co., Ltd., 7*s.* 6*d.*)

Electrons, Electric Waves, and Wireless Telephony. By J. A. FLEMING, M.A., D.Sc., F.R.S. (The Wireless Press, Ltd., 7*s.* 6*d.*)

The Radio Experimenter's Handbook. By PHILIP R. COURSEY, B.Sc. Part II. (The Wireless Press, Ltd., 3*s.* 6*d.*)

How to build Amateur Valve Stations. By P. R. COURSEY, B.Sc. (The Wireless Press, 3*s.* 6*d.*)

Special Steels. By THOS. H. BURNHAM, B.Sc. (Sir Isaac Pitman & Sons, Ltd., 5*s.* net.)

Plant and Flower Forms. By E. J. G. KIRKWOOD. (Sidgwick & Jackson, Ltd., 7*s.* 6*d.*)

Interfacial Forces and Phenomena in Physiology. By SIR WILLIAM M. BAYLISS. (Methuen & Co., 7*s.* 6*d.*)

Advanced Practical Physics for Students. By B. L. WORSNOP and H. J. FLINT. (Methuen & Co., 21*s.*)

British Plant Names and their Derivations. By R. J. Harvey-Gibson, C.B.E., D.Sc. (A. & C. Black, Ltd., 2s. 6d.)

The Works of Aristotle. Translated into English Meteoralogica. (Oxford: at the Clarendon Press, 7s. 6d.)

On the Existence of a Hitherto Unrecognised Factor Essential for Reproduction. By Herbert M. Evans and K. Scott Bishop. (Reprint from *Science*, vol. lxi.)

Alternating-current Electrical Engineering. By M. T. Maccall. (University Tutorial Press, Ltd., 15s.)

PSYCHOLOGY

Character and the Unconscious. A critical exposition of the psychology of Freud and Jung. By J. H. Van der Hoop. An authorised translation by Elizabeth Trevelyan. (Kegan Paul, 10s. 6d.)

A Study of American Intelligence. By Carl C. Brigham, Ph.D. A foreword by Robert H. Yerkes, Ph.D. (Humphrey Milford, Oxford University Press, 16s.)

Heredity and Child Culture. By Henry Dwight Chapin, M.D. (Routledge, 6s.)

MISCELLANEOUS

The Elephant Man, and Other Reminiscences. By Sir Frederick Treves, Bart., G.C.V.O., etc. (Cassell & Co., Ltd., 7s. 6d.)

Below the Snow Line. By Douglas W. Freshfield, D.C.L. (Constable & Co., Ltd., 18s.)

The Railroad Picture-book. Pictogram No. 1. (The Pictogram Co., Washington, D.C., 25 cents.)

The Oldest Letters in the World—Tell us What? By Mrs. Sidney Bristowe. (George Allen & Unwin, 5s.)

Correspondence

To the Editor of Discovery

Dear Sir,

Professor Mawer, in his article on "Some Types of English Place-names," in the April number of Discovery, gives the element *ea* as meaning stream or river. Years ago I was living on the edge of the fen district; and during my travels across the fens, I found a series of names containing the *ea* element, i.e. Eastrea, Oldeamere, Waldersea, Stonea, and Manea.

I was told that the *ea* element of these names meant *island*.

I should be much obliged if Professor Mawer would inform me if in the fen district it has this interpretation, or whether I have been misinformed.

I should also be pleased if he would enlighten me whether or not the originals of Ramsey, Whittlesey, and Thorney, were Ramsea, Whittlesea, and Thornea.

I am, yours truly,

Albert R. Thornewell.

Fir Tree House,
Mucklow Hill,
Hales Owen.
April 11, 1923.

[Professor Mawer has been kind enough to send us the following solution of the problems raised by our correspondent.—Ed.]

In the case of *Eastrea*, Professor Skeat, in the *Place-names of Cambridgeshire*, gives the early form *Estrey*. He mentions *Stonea* and *Manea* and suggests that they once had the suffix *ey*, but he could give no early form. Confirmation of his view is to be found, however, in a form *Maneye* in an Inquisition of Edward I. He further gives early forms of *Anglesea, Horningsea*, and *Whittlesea* (which he spells thus) in *eye*, and there is no doubt that he is correct in stating that in all these names we have the regular M.E. development of Old English *eg*, "island," and not a form derived from O.E. *ea*, "river."

Exactly how the peculiar change from the normal *-ey* to the modern and irregular *-ea* arose it is difficult to say, but the suggestion may be made that in names like *Whittle-sey, Ram-sey, Horning-sey*, the presence of the *s* in the middle of the name led to a piece of folk-etymologising whereby the words were divided as suggested by the hyphen above inserted, the idea being that the suffix was really the word *sea*, meaning "lake," and referring to the neighbouring mere or fen. When once this idea arose the spelling with final *ea* would soon be introduced to confirm the idea. Later that spelling was extended by analogy to other names like *Eastrea, Manea, Stonea*, which had no medial *s*. *Ramsey* and *Thorney* are also *ey* names and were never, so far as the evidence goes, even spelled with final *ea*. A. M.

To the Editor of Discovery

Dear Sir,

In a letter of July 19, 1921, of your issue I note that the reason or purpose of the prehistoric cup-markings is not understood.

Whenever I have come across them in India (they are fairly common), it always struck me that such depressions in stones were produced by abrasion in pounding grain. Only once I came across people actually pounding their grain in these holes. Ordinarily they use a stone mortar and pestle, the hole getting enlarged by use.

It will probably be found that in erecting dolmens they used the slabs in which grain had been pounded. The more stone abraded away, the easier to erect, and the cup depressions were a guarantee of strength of the material.

Saucer-like depressions in stone occur all over India where there is gold: and it is worth noting that the ancients never ground their ore in stone of the same species out of which the gold had been extracted. For instance, the grinding stones on the Kolar Gold Field are always of granite or gneiss, and this rock lies away from the old workings for gold. They used dolerite, and they probably knew gold never was found in that rock.

Louis Stromeyer.

Coromandel P.O.,
K.G. Field,
Mysore State, S. India.
February 27, 1923.

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